Vol. XVIII. *April, 1910.* *No. 5.*

BIOLOGICAL BULLETIN

I. TRUSTEES

AUGUST, 1909

EX OFFICIO

F. R. LILLIE, *Director,* University of Chicago.
GILMAN A. DREW, *Assistant Director,* University of Maine.
D. BLAKELY HOAR, *Treasurer,* 161 Devonshire Street, Boston, Mass.
THOS. H. MONTGOMERY, JR., *Clerk of the Corporation,* University of Pennsylvania.

TO SERVE UNTIL 1913

NATHANIEL L. BRITTON..2965 Decatur Avenue, Bronx, New York City.
S. F. CLARKE .....Williams College, Williamstown, Mass.
CHARLES COOLIDGE.....Ames Building, Boston, Mass.
C. R. CRANE.....2559 Michigan Boulevard, Chicago, Ill., President of the Board.
ALFRED G. MAYER.....Carnegie Institution, Washington, D. C.
T. H. MORGAN.....Columbia University.
ERWIN F. SMITH.....United States Department of Agriculture, Washington, D. C.
E. B. WILSON.....Columbia University.

TO SERVE UNTIL 1912

M. J. GREENMAN.....Wistar Institute of Anatomy and Biology, Philadelphia.
C. W. HARGITT.....Syracuse University.
C. A. HERTER.....University and Bellevue Medical School, New York City.
H. S. JENNINGS.....Johns Hopkins University.
GEORGE LEFEVRE.....University of Missouri.
WILLIAM LIBBEY.....Princeton University.
A. P. MATHEWS.....University of Chicago.
G. H. PARKER.....Harvard University.

TO SERVE UNTIL 1911

H. C. BUMPUS.....American Museum of Natural History, New York City.
W. A. LOCY.....Northwestern University, Evanston, Ill.
JACQUES LOEB.....University of California, Berkeley, Calif.
F. P. MALL.....Johns Hopkins University.
GEORGE T. MOORE.....Washington University, St. Louis.
L. L. NUNN.....Telluride, Colo.
JOHN C. PHILLIPS.....299 Berkeley Street, Boston, Mass.
C. O. WHITMAN.....University of Chicago.

TO SERVE UNTIL 1910

E. G. CONKLIN.....Princeton University.
ROSS G. HARRISON.....Yale University.
CAMILLUS G. KIDDER....27 William Street, New York City.
M. M. METCALF.....Oberlin College, Oberlin, Ohio.
WILLIAM PATTEN.....Dartmouth College, Hanover, New Hampshire.
D. P. PENHALLOW.....McGill University, Montreal, Canada.
JACOB REIGHARD.....University of Michigan, Ann Arbor, Mich.
W. B. SCOTT.....Princeton University.

II. ACT OF INCORPORATION

No. 3170.

COMMONWEALTH OF MASSACHUSETTS

Be It Known, That whereas Alpheus Hyatt, William Sanford Stevens, William T. Sedgwick, Edward G. Gardiner, Susan Minns, Charles Sedgwick Minot, Samuel Wells, William G. Farlow, Anna D. Phillips and B. H. Van Vleck have associated themselves with the intention of forming a Corporation under the name of the Marine Biological Laboratory, for the purpose of establishing and maintaining a laboratory or station for scientific study and investigation, and a school for instruction in biology and natural history, and have complied with the provisions of the statutes of this Commonwealth in such case made and provided, as appears from the certificate of the President, Treasurer, and Trustees of said Corporation, duly approved by the Commissioner of Corporations, and recorded in this office;

Now, therefore, I, HENRY B. PIERCE, Secretary of the Commonwealth of Massachusetts, *do hereby certify* that said A. Hyatt, W. S. Stevens, W. T. Sedgwick, E. G. Gardiner, S. Minns, C. S. Minot, S. Wells, W. G. Farlow, A. D. Phillips, and B. H. Van Vleck, their associates and successors, are legally organized and established as, and are hereby made, an existing Corporation, under the name of the MARINE BIOLOGICAL LABORATORY, with the powers, rights, and privileges, and subject to the limitations, duties, and restrictions, which by law appertain thereto.

Witness my official signature hereunto subscribed, and the seal of the Commonwealth of Massachusetts hereunto affixed, this twentieth day of March, in the year of our Lord ONE THOUSAND, EIGHT HUNDRED AND EIGHTY-EIGHT.

HENRY B. PIERCE,
Secretary of the Commonwealth.

[SEAL.]

III. BY-LAWS OF THE CORPORATION OF THE MARINE BIOLOGICAL LABORATORY

I. The annual meeting of the members shall be held on the second Tuesday in August, at the Laboratory, in Woods Hole, Mass., at 12 o'clock noon, in each year, and at such meeting the members shall choose by ballot a Treasurer and a Clerk, who shall be, *ex officio*, members of the Board of Trustees, and Trustees as hereinafter provided. At the annual meeting to be held in 1897, not more than twenty-four Trustees shall be chosen, who shall be divided into four classes, to serve one, two, three, and four years, respectively, and thereafter not more than eight Trustees shall be chosen annually for the term of four years. These officers shall hold their respective offices until others are chosen and qualified in their stead. The Director and Assistant Director, who shall be chosen by the Trustees, shall also be Trustees, *ex officio*.

II. Special meetings of the members may be called by the Trustees, to be held in Boston or in Woods Hole at such time and place as may be designated.

III. The Clerk shall give notice of meetings of the members by publication in some daily newspaper published in Boston at least fifteen days before such meeting, and in case of a special meeting the notice shall state the purpose for which it is called.

IV. Twenty-five members shall constitute a quorum at any meeting.

V. The Trustees shall have the control and management of the affairs of the Corporation; they shall present a report of its condition at every annual meeting; they shall elect one of their number President and may choose such other officers and agents as they may think best; they may fix the compensation and define the duties of all the officers and agents; and may remove them, or any of them, except those chosen by the members, at any time; they may fill vacancies occurring in any manner in their own number or in any of the offices. They shall from time to time elect members to the Corporation upon such terms and conditions as they may think best.

VI. Meetings of the Trustees shall be called by the President, or by any two Trustees, and the Secretary shall give notice thereof by

written or printed notice sent to each Trustee by mail, postpaid. Seven Trustees shall constitute a quorum for the transaction of business. The Board of Trustees shall have power to choose an Executive Committee from their own number, and to delegate to such Committee such of their own powers as they may deem expedient.

VII. The President shall annually appoint two Trustees, who shall constitute a committee on finance, to examine from time to time the books and accounts of the Treasurer, and to audit his accounts at the close of the year. No investments of the funds of the Corporation shall be made by the Treasurer except approved by the finance committee in writing.

VIII. The consent of every Trustee shall be necessary to a dissolution of the Marine Biological Laboratory. In case of dissolution, the property shall be given to the Boston Society of Natural History, or some similar public institution, on such terms as may then be agreed upon.

IX. These By-Laws may be altered at any meeting of the Trustees, provided that the notice of such meeting shall state that an alteration of the By-Laws will be acted upon.

X. Any member in good standing may vote at any meeting, either in person or by proxy duly executed.

IV. REPORT OF THE TRUSTEES

In making their last annual report the trustees had to announce, with deep regret, the retirement of Professor Whitman from the directorship of the laboratory. As was stated in that report, Professor Whitman was succeeded, in August, 1909, by Professor Frank R. Lillie, whose annual report is submitted herewith. At the same time Professor Gilman A. Drew was appointed to succeed Professor Lillie as Assistant Director. The trustees desire to express their satisfaction that the high ideals of work and the spirit of coöperative endeavor, which the laboratory has so long striven to uphold, have been fully maintained, and that the institution has every reason to look hopefully to the future.

The trustees announce with much pleasure that the plans looking towards the construction of a new and permanent laboratory building have in the past year made substantial progress. At the Baltimore meeting, in December, 1908, was announced a gift from the President of the Board of Trustees, Mr. Charles R. Crane, for the purchase of additional land at Woods Hole with a view to the future erection of such a laboratory building. With the approval of the donor, the fund thus acquired was used for the purchase of the tract known as the "Kidder lot," lying between the stone building and the street on which the original laboratory building faces. At the August meeting in 1909 Mr. Coolidge offered to prepare a tentative plan for a permanent fire-proof building, to be erected on this site, and a committee of the trustees was appointed to secure suggestions and details incident to the preparation of this plan, and to coöperate with the Corporation committee on building. At the Boston meeting, in December, 1909, a new committee was appointed to carry on this work, and it is hoped that during the present year the plans may take definite shape.

The time has come when the laboratory should be provided with a building or buildings commensurate with the extent and

importance of the work in which it is engaged, and which will not suffer by comparison with the laboratories of other institutions of similar aim. The steady expansion of our work in past years has from time to time made imperative the construction of new buildings; and that these have fulfilled their purpose is abundantly demonstrated by the work that has been done in them. Owing to financial limitations, however, most of these buildings were of a flimsy and temporary character, sometimes erected in haste to meet an immediate and pressing need; and they are not only in themselves imperfectly adapted to their purpose but have often called forth expressions of astonishment from foreign and other visitors that so much could have been accomplished with accommodations so primitive. The cramped and often noisy working quarters, the unsteady foundations, imperfect equipment and inflammable nature of these buildings impress every worker and visitor at the laboratory; and nothing is plainer than the need of a substantial, well equipped, safe and dignified new laboratory to form the principal center of the work at Woods Hole. The acquisition of a suitable site for this purpose is an important forward step, and the generous offer of Mr. Coolidge places the project before us in concrete form. It is the earnest hope of the trustees that the means may soon be found for carrying out the plans that are now being formulated; and it is their belief that when this has been done the laboratory will enter upon a new period of development that contains great possibilities of usefulness.

V. TREASURER'S REPORT

FOR THE YEAR ENDING DECEMBER 31, 1909

INCOME

Annual dues		$ 666.00	
Donations		17,240.00	
Miscellaneous:			
Interest on deposits	$44.40		
Bath house	78.45		
Mess (net)	26.74		
Rent of microscopes	49.00		
Sundries	6.85	205.44	
Supply Department		8,549.55	
Tuitions		3,708.35	$30,369.34

EXPENSES

Administration	$ 900.00	
Advertising	80.72	
Biological Bulletin (net)	1,094.69	
Boats and launch	1,595.92	
Chemicals, chemist supplies, etc.	659.32	
Fish trap (net)	113.16	
Instructors' salaries	2,725.00	
Insurance	98.78	
Interest	150.00	
Labor	3,566.58	
Periodicals and library supplies	868.39	
Postage	79.24	
Real estate	7,600.00	
Repairs	1,011.21	
Sundries	2,262.09	
Supply department	6,380.69	$29,185.79
Surplus		$ 1,183.55

ITEMIZED LIST OF SUNDRY EXPENSES FOR THE YEAR 1909

Announcements	$ 69.00	
Care of cemetery lot	2.00	
Cleaning	35.00	
Crash	50.45	
Dr. Drew's expenses	157.49	
Dr. Lillie's expenses	371.35	
Engrossing Woods Hole greetings	20.00	
Exchange on checks	32.68	
Expenses W. C. Curtis	44.85	
Expenses purchase of land at Woods Hole	10.31	
Express	158.95	
Gardener	4.70	
Sundry supplies	169.06	
Hubbard, J. G., services	60.00	
Instruments, laboratory supplies	131.15	
Lamps	13.85	
Laundry	17.29	
Lecture expense	25.00	
Plowing	3.00	
Premium on bond	7.50	
Rent of microscopes	44.16	
Rent of typewriter	11.50	
Stationary, office supplies	129.40	
Sundries	32.43	
Teaming and livery	14.00	
Telephone	61.97	
Treasurer's office, clerical services	520.00	
Water	65.00	$2,262.09

MARINE BIOLOGICAL LABORATORY
INVESTMENTS

JANUARY 1, 1910

Reserve Fund

Amount of fund December 1, 1899	$4,553.14	
Received from life memberships	600.00	
Income to January 1, 1910	1,898.15	
Gain from sale of securities	372.20	
	7,423.49	
Paid for current expenses of laboratory	6,000.00	$1,423.49
Reserve fund now consists of the following:		
$3000 Am. Tel. & Tel. Co. 4s, cost	2,921.25	
6 shs. Am. Smelting & Refining Co. pfd.	732.00	
Cash	770.24	
	4,423.49	
The above stocks and bonds are held as collateral for loan of	3,000.00	1,423.49

Library Fund

Amount of fund December 1, 1899	866.15	
Income	626.47	
Gain from sale of securities	74.88	
Sale of rights	.81	1,568.31
Library Fund now consists of the following:		
3 shs. Am. Tel. & Tel. Co., cost	383.25	
⅘ of $1000 Am. Tel. & Tel. Co. 4s, cost	779.00	
1 sh. Am. Smelting & Refining Co. Pfd., cost	122.00	
Cash	284.06	1,568.31

Lucretia Crocker Fund

Amount of fund December 1, 1899	2,500.00	
Income after paying students' fees	488.91	
Sale of rights	.94	2,989.85

Lucretia Crocker Fund now consists of the following:

18 shs. Vermont & Mass. R. R. Co., cost....	2,416.50	
1 sh. West End St. Ry. Co., cost.....	83.00	
1 sh. Am. Tel. & Tel. Co., cost.....	127.75	
$\frac{1}{5}$ of $1000 Am. Tel. & Tel. Co., 4s, cost.....	194.75	
Cash	167.85	2,989.85

REPORTS OF THE TREASURER, 1906 TO 1909

SUMMARY OF THE REPORTS OF THE TREASURER OF THE MARINE BIOLOGICAL LABORATORY JANUARY 1, 1907, TO JANUARY 1, 1910

Receipts

Cash on hand January 1, 1907	$ 1.19	
Income for 1907	15,779.70	
Income for 1908	17,452.18	
Income for 1909	30,369.34	$63,602.41

Disbursements

Expenses for 1907	$15,638.38	
Expenses for 1908	17,476.25	
Expenses for 1909	29,185.79	
Cash on hand December 27, 1909	1,301.99	$63,602.41

VI. THE DIRECTOR'S REPORT

To the Trustees of the Marine Biological Laboratory.

Gentlemen: I have the honor to submit herewith a report on the work of the twenty-second session of the Marine Biological Laboratory for the year 1909. The year has been a successful one as measured by the growth of all departments, by the genuine and hearty coöperation of naturalists and institutions, and by the increase in our resources. If any confirmation were needed of the necessity and value of the work of the Laboratory, this year has furnished it.

Trustees.—At the regular summer meeting of the corporation, the following new members were elected to the board of trustees: Nathaniel L. Britton, Director-in-Chief of the New York Botanical Garden, Alfred G. Mayer, Director of the Marine Laboratory of the Carnegie Institution, and George Lefevre, Professor of Zoölogy in the University of Missouri. The board is to be congratulated on the accession of these gentlemen to its membership, which is now complete, consisting of thirty-two regular members and four members *ex officio*.

Staff.—The staff of investigation and instruction in 1909 comprised twenty-seven members, representing seventeen universities and colleges. There was no change in heads of departments; but a new course was offered by Professor Edward G. Spaulding on "Philosophical Aspects of Biology and Allied Sciences," which aroused much interest. The members of the staff of investigation rendered their services free.

The work of organizing the library on a more effective basis received a great impetus owing to the efforts of the librarian, Dr. Knower. It is becoming increasingly important that more funds should be devoted to the purchase of books. There is no question that the enlargement of our library will greatly strengthen our position with the scientific public.

Attendance.—The total attendance in 1909 was 129 as against 100 in 1908. Of this number 66 were investigators and 63 stu-

dents. The gain was divided almost equally between investigators and students, fourteen of the former and fifteen of the latter. The class of beginning investigators alone showed a gain of 10, 16 in 1909 as against 6 in 1908. This was one of the most encouraging features of the session. We should continue our efforts to increase the attendance of this class of workers, because it is one of the most important functions of our Laboratory to assist in the making of investigators; and because those who are to succeed us in the work of advancing our science and in the management of the Laboratory are represented by the younger investigators of to-day.

Subscribing Institutions.—The number of subscribing institutions was 19 in 1909 as against 17 in 1908; Princeton University, Oberlin College, and the University of Missouri were new, and we hope permanent, accessions. We are still, however, far from having reached the limit of growth in this respect and we may confidently expect new additions. A committee of the board is now engaged in correspondence with institutions on this subject.

Donations.—The president of the board has again provided for the deficit in running expenses. He has also presented the Laboratory with a large piece of land having 157 feet of frontage on the main street and more than twice that on East Street, which unites our two main holdings and forms an ideal site for the erection of future permanent buildings.

Supply Department.—The business of the Supply Department continues to grow in a satisfactory manner; it has been necessary to furnish Mr. Gray with two assistant collectors during the year instead of one as formerly, and a bookkeeper is also employed throughout the year, but the growth of the business has been more than sufficient to pay for the additional expense involved.

In conclusion, I wish to express my thanks to the board of trustees for their hearty support and to the members of the staff for their loyal coöperation in the work of the Laboratory.

There are appended as parts of this report (1) a list of the staff, (2) the names of subscribing institutions, (3) lists of investigators and students in attendance, (4) a comparative tabular view of attendance, (5) the evening lectures, (6) a list of members of the Corporation.

THE STAFF, 1909

F. R. LILLIE, DIRECTOR,
Professor of Embryology, University of Chicago.

GILMAN A. DREW, ASSISTANT DIRECTOR,
Profesor of Biology, University of Maine.

ZOÖLOGY

I. INVESTIGATION

Zoölogy and Embryology

E. G. CONKLIN.....Professor of Zoölogy, Princeton University.
GILMAN A. DREW.....Professor of Biology, University of Maine.
ROSS G. HARRISON.....Professor of Comparative Anatomy, Yale University.
GEORGE LEFEVRE.....Professor of Zoölogy, University of Missouri.
WARREN H. LEWIS.....Associate Professor of Anatomy, Johns Hopkins University.
FRANK R. LILLIE.....Professor of Embryology, University of Chicago.
THOS. H. MONTGOMERY, JR.Professor of Zoölogy, University of Pennsylvania.
E. B. WILSON.....Professor of Zoölogy, Columbia University. (Absent in 1909.)

II. INSTRUCTION

WINTERTON C. CURTIS...Professor of Zoölogy, University of Missouri.
GIDEON S. DODDS.....Fellow in Zoölogy, University of Pennsylvania.
A. S. PEARSE.....Instructor in Zoölogy, University of Michigan.
JOHN W. SCOTT.....Westport High School, Kansas City.

HENRY J. SPENCER Assistant in Zoölogy, Columbia University.
EDWARD E. WILDMAN....Central High School, Philadelphia.

EMBRYOLOGY

I. INVESTIGATION. (See Zoölogy)

II. INSTRUCTION

GILMAN A. DREW.....Professor of Biology, University of Maine.
LORANDE L. WOODRUFF..Assistant Professor of Biology, Yale University.
WILLIAM E. KELLICOTT..Professor of Biology, Woman's College of Baltimore.
ROBERT A. BUDINGTON...Associate Professor of Zoölogy, Oberlin College.

PHYSIOLOGY

I. INVESTIGATION

ALBERT P. MATHEWS....Professor of Physiological Chemistry, University of Chicago.
R. S. LILLIE.....Instructor in Comparative Physiology, University of Pennsylvania.

II. INSTRUCTION

H. H. NEWMAN.....Professor of Zoölogy, University of Texas.
FRANK P. KNOWLTON....Professor of Physiology, Syracuse University.
F. H. PIKE.....Instructor in Physiology, University of Chicago.

PHILOSOPHICAL ASPECTS OF BIOLOGY AND ALLIED SCIENCES

LECTURES

EDWARD G. SPAULDING...Assistant Professor of Philosophy, Princeton University.

BOTANY

GEORGE T. MOORE.....Professor of Plant Physiology and Applied Botany, Washington University.
HENRY KRAEMER.....Professor of Botany and Pharmacognosy, Philadelphia College of Pharmacy.
M. B. THOMAS.....Professor of Botany, Wabash College.
GEORGE R. LYMAN.....Assistant Professor of Botany, Dartmouth College.

LIBRARY

H. McE. KNOWER.....Associate in Anatomy, Johns Hopkins University, Librarian.

OLIVER S. STRONG.....Instructor in Anatomy, Columbia University, Chemist

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G. M. GRAY.....Curator of Supply Department.
JACOB SCHRAMM.....Wabash College, Collector in Botany.
JOHN VEEDER.....Cockswain.

INVESTIGATORS

1909

OCCUPYING ROOMS

1. ZOÖLOGY

ADDISON, W. H. F., University of Pennsylvania.
BECKWITH, CORA J., Instructor in Biology, Vassar College.
BENTLEY, MADISON, Assistant Professor of Psychology, Cornell University.
BUDINGTON, ROBERT A., Associate Professor of Zoölogy, Oberlin College.
CLARK, ELIOT R., Instructor in Anatomy, Johns Hopkins Medical School.
CONKLIN, E. G., Professor of Zoölogy, Princeton University.
CURTIS, W. C., Professor of Zoölogy, University of Missouri.
DODDS, GIDEON S., Fellow in Zoölogy, University of Pennsylvania.
DREW, GILMAN A., Professor of Biology, University of Maine.
GOLDFARB, A. J., Investigator, Columbia University.
GUDERNATSCH, J. F., Instructor in Embryology and Experimental Morphology, Cornell University Medical School, New York City.
HARRISON, ROSS G., Bronson Professor of Comparative Anatomy, Yale University.
HARVEY, B. C. H., Assistant Professor of Anatomy, University of Chicago.
KELLICOTT, WILLIAM E., Professor of Biology, Woman's College, Baltimore.
KING, HELEN D., Assistant in Anatomy, Wistar Institute of Anatomy and and Biology.
KIRKHAM, WILLIAM B., Instructor in Biology, Yale University.
KNOWER, H. McE., University of Toronto.
LEFEVRE, GEORGE, Professor of Zoölogy, University of Missouri.
LILLIE, FRANK R., Professor of Embryology, University of Chicago.
LEWIS, WARREN H., Associate Professor of Anatomy, Johns Hopkins University.
MCDONOUGH, JAMES, Decatur Ill.
MCGILL, CAROLINE, Instructor in Anatomy, University of Missouri.
MAYER, ALFRED G., Carnegie Institution, Washington, D. C.
MONTGOMERY, THOS. H., JR., Professor of Zoölogy, University of Pennsylvania.
MORGAN, T. H., Professor of Experimental Zoölogy, Columbia University.
MORRILL, C. V., Lecturer in Histology and Embryology, Syracuse University.
MURBACH, LOUIS, Central High School, Detroit, Mich.
PAYNE, FERNANDUS, University of Indiana.
PEARSE, A. S., Instructor in Zoölogy, University of Michigan.
QUACKENBUSH, L. S., Columbia University.
RICKETTS, H. T., Assistant Professor of Pathology, University of Chicago.
SCOTT, JOHN W., Westport High School, Kansas City, Mo.
SPENCER, HENRY J., Assistant in Zoölogy, Columbia University.
STOCKARD, CHARLES R., Assistant Professor of Embryology and Comparative Anatomy, Cornell Medical School.

STRONG, OLIVER S., Instructor in Anatomy, Columbia University.
WILDMAN, EDWARD E., Central High School, Philadelphia, Pa.
WILSON, E. B., Professor of Zoölogy, Columbia University.
WOODRUFF, L. L., Assistant Professor of Biology, Yale University.
YERKES, ROBERT M., Professor of Comparative Psychology, Harvard University.

2. PHYSIOLOGY

BRADLEY, HAROLD C., Assistant Professor of Physiological Chemistry, University of Wisconsin.
BUNZEL, H. H., University of Chicago.
KNOWLTON, FRANK P., Professor of Physiology, Syracuse University.
LILLIE, R. S., Instructor in Physiological Zoölogy, University of Pennsylvania.
MATHEWS, ALBERT P., Professor of Physiological Chemistry, University of Chicago.
NEWMAN, H. H., Professor of Zoölogy, University of Texas.
PIKE, FRANK H., Instructor in Physiology, University of Chicago.

3. BOTANY

KRAEMER, HENRY, Professor of Botany and Pharmacognosy, Philadelphia College of Pharmacy.
LYMAN, GEORGE R., Assistant Professor of Botany, Dartmouth College.
MOORE, GEORGE T., Professor of Plant Physiology and Applied Botany, Washington University, St. Louis.
THOMAS, MASON B., Professor of Botany, Wabash College.

OCCUPYING TABLES

1. ZOOLOGY

BOONE, W. D., University of Missouri.
BRAGG, LUTHER C., Assistant Entomologist, Agricultural College, Fort Collins, Colo.
BROWNE, ETHEL N., Instructor in Mathematics and Science, Bennett School, Millbrook, New York.
CARTER, J. L., University of Missouri.
CHIDESTER, FLOYD E., Instructor in Biology, DePauw University.
EDWARDS, DAYTON J., Tutor in Natural History, College of the City of New York.
GRAVE, B. H., Associate Professor of Zoölogy, Earlham College, Richmond, Indiana.
HARVEY, E. NEWTON, Columbia University.
LINTON, ELEANOR A., Smith College.
MCKIBBEN, PAUL S., University of Chicago.
SHOREY, MARIAN L., Professor of Biology, Milwaukee-Downer College.
THOMPSON, CRYSTAL, University of Michigan.
SPOONER, GEORGINA B., Columbia University.
WALLACE, EDITH M., Instructor in Zoölogy, University of Maine.

2. PHYSIOLOGY

HUGHES, WINONA A., Instructor in Chemistry, Mount Holyoke College.
TINKHAM, FLORENCE L., 56 Temple Street, Springfield, Mass.

STUDENTS

1909

INVERTEBRATE ZOÖLOGY

1. Abbott, Margaret B., 413 W. Front Street, Plainfield, Mass.
2. Anderson, Sarah R., Readville, Mass., c/o A. L. Rotch.
3. Bayer, M. Elizabeth, Woman's College, Baltimore.
4. Belt, Mabel, Woman's College, Baltimore.
5. Bryan, Mary M., Teacher, Mary Institute, St. Louis, Mo.
6. Clarke, Helen Dorothy, 1 Autumn St., Fenway, Boston, Mass.
7. Farmer, Chester J., Teaching Fellow in Biological Chemistry, Harvard Medical School.
8. Farnham, Charlotte, Instructor in Biology, High School, Poughkeepsie.
9. Forbes. W. T. M., Fellow, Clark University.
10. Franklin, George Dwight, Assistant in Zoölogy, American Museum of Natural History.
11. Gannett, Charlotte K., Vassar College.
12. Gannett, Lewis Stiles, University of Rochester.
13. Gilmore, Ralph J., Instructor, Lehigh University.
14. Goldberger, Joseph, Assistant Surgeon, Hygienic Laboratory, Washington.
15. Iseley, F. B., Instructor in Biology, University of Oklahoma.
16. Just, Ernest E., Instructor, Howard University.
17. Leavitt, George C., University of Maine.
18. Leonard, Helen A., Vassar College.
19. Nicholson, Mary, Western College, Oxford, Ohio.
20. Ober, Marion K., High School, Katonah, N. Y.
21. Ogden, Harold B., Instructor, Park College, Parkville, Mo.
22. Osborne, Frank J., University of Rochester.
23. Mellen, Ida M., Brooklyn, New York.
24. Pettibone, C. J. V., Research Assistant Biological Chemistry, Harvard Medical School.
25. Prentiss, Henrietta, Instructor in Zoölogy, Normal College, New York City.
26. Redelings, Leslie H., Northwestern University.
27. Reid, Charles D. Jr., Johns Hopkins Medical School.
28. Root, Francis M., Oberlin College.
29. Ruso, Ada, Laboratory Assistant, Oberlin College.
30. Russell, Frederick F., Curator Army Medical Museum, Washington, D. C.
31. Showalter, Benjamin R., Steele High School, Dayton, Ohio.
32. Sterling, Eugenie, 1129 Louisiana St., Lawrence, Kansas.
33. Stocking, Ruth J., Woman's College, Baltimore.
34. Wells, Laura P., Mount Holyoke College.
35. Watters, Florence A., Smith College.
36. Wright, Albert H., Instructor in Zoölogy, Cornell University.

EMBRYOLOGY

1. Armington, Sarah R., Ingleside School, New Milford, Conn.
2. Clark, Mary A., Instructor, Mount Holyoke College.
3. Dawson, Ava B., 97 Mountfort St., Boston, Mass.
4. Day, Lucy W., Laboratory Assistant, Mount Holyoke College.
5. Ferguson, J. S., Assistant Professor of Histology, Cornell Medical School.
6. Holt, Caroline M., Instructor in Zoölogy, Wellesley College.
7. Howland, Ruth B., Sweet Briar College, Va.
8. Packard, Charles, Instructor in Biology, Williams College.
9. Reinke, Edwin E., 116 South New Street, Bethlehem, Pa.
10. Romine, A. P., Instructor in Zoölogy, State Normal School, Bellingham Wash.
11. Smith, Bertram G., Instructor in Zoölogy, University of Wisconsin.
12. Tompkins, Elizabeth M., White Plains High School, New York.

PHYSIOLOGY

1. Carr, Emma P., University of Chicago.
2. Hayes, Charles H., Professor of Christian Apologetics, General Theological Seminary, New York City.
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4. Schoonover, Elizabeth H., Smith College.
5. Spalding, Caroline, Wellesley College.
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TABULAR VIEW OF ATTENDANCE

	1907	1908	1909
INVESTIGATORS—Total	60	52	66
Occupying Rooms			
Zoölogy	32	32	39
Physiology	8	6	7
Botany	10	8	4
Occupying Tables			
Zoölogy	9	6	14
Physiology	1		2
STUDENTS—Total	47	48	63
Zoölogy	34	19	36
Embryology		15	12
Physiology	4	3	9
Botany	9	11	6
UNIVERSITIES AND COLLEGES REPRESENTED	47	51	47
Investigators	26	25	27
Students	21	26	20
SCHOOLS REPRESENTED	13	5	14
Investigators	4	2	3
Students	9	3	11

SUBSCRIBING INSTITUTIONS, 1909

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SMITH COLLEGE.

UNIVERSITY OF CHICAGO.

COLUMBIA UNIVERSITY.

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VASSAR BROTHERS' INSTITUTE.

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OBERLIN COLLEGE.

UNIVERSITY OF KANSAS WOMAN'S TABLE SUPPORTED BY MRS. ROBINSON.

LUCRETIA CROCKER SCHOLARSHIP, BOSTON PUBLIC SCHOOLS.

EVENING LECTURES, 1909

T. H. MORGAN....."Mendelian Inheritance of Coat and Eye Color in Mice" ..... July 6.

A. P. MATHEWS....."The Mechanism of Some Protoplasmic Combustions" ..... July 9.

ROSS G. HARRISON....."Protoplasmic Movement as a Factor in the Development of the Nervous System" ..... July 13.

C. B. DAVENPORT....."Variation in Dominance" ..... July 16.

HENRY KRAEMER....."Experiments on the Modification of Color in Plants"..... July 23.

T. H. MONTGOMERY, JR..."Architectural Habits of Spiders" July 27.

W. L. TOWER....."The Role of External Factors in Variation and Heredity" .... July 29.

H. H. NEWMAN....."A Unique Form of Reproduction in the Nine-banded Armadillo" July 30.

M. M. METCALF....."The Protozoan Nucleus" ..... Aug. 6.

C. H. EIGENMANN....."An Expedition to British Guiana and the Kaieteur" ..... Aug. 9.

G. H. PARKER....."Sponge Reactions and the Origin of the Nervous System" .... Aug. 11.

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OVULATION IN MAMMALS, WITH SPECIAL REFERENCE TO THE MOUSE AND RAT.

WILLIAM B. KIRKHAM.

Ovulation and its connection, if any, with pairing is a subject that has long engaged the attention of mammalian embryologists. As long ago as 1828 Von Baer made the statement, seemingly based more upon theoretical than upon experimental grounds, that the Graafian follicles of mammals appear not to rupture without pairing, or some analogous stimulation of the female sexual organs. It would seem to be a simple matter to determine in a given mammal whether ovulation was, or was not dependent upon copulation, but the literature of the subject shows long controversies about this point. The matter can best be taken up by considering individually the animals thus far studied. The egg of the dog was carefully investigated by Bischoff ('45), who declared that in that animal ovulation is entirely independent of pairing. This observation has since been confirmed by Marshall and Jolly ('05), who also found that the bitch has typically two sexual seasons each year. Further confirmation has come from Ancel and Bouin ('08), who, in addition to finding ovulation occurring independently of copulation, discovered that the Graafian follicles in the dog rupture in turn.

Ovulation phenomena in the guinea-pig gave rise to a spirited controversy between Bischoff ('52 and '66), who claimed that the Graafian follicles in that animal ruptured entirely independently of pairing, and Reichert ('61), who declared that ovulation only occurred nine to ten hours after copulation had taken place. In his second paper, replying to Reichert, Bischoff states that he has experimentally demonstrated in dogs, rabbits, guinea-pigs, rats, sheep and swine that follicles mature and rupture without relation to pairing, the full data of this work being given in an earlier paper (Bischoff '44). Hensen ('76), in his paper on the early development of the guinea-pig, quotes the opposing views of Bischoff and Reichert, without expressing any opinion

of his own, and Lams and Doorme ('07) quote Reichert alone. The careful researches of Rubaschkin ('05), however, have definitely confirmed Bischoff's original contention, and it may therefore be considered as finally settled that in the guinea-pig ovulation and pairing are essentially independent phenomena.

The rabbit's egg has been studied by Barry ('39), Bischoff ('42), Coste ('47), Heap ('05), and by Dubreuil and Regaud ('08). Barry, and the last three authors named above find, contrary to Bischoff, that the rabbit cannot ovulate until a short time after pairing has occurred, but Coste claims to have induced ovulation by taking females which, isolated from males, had been in heat for a number of days, and allowing males to cover them without, however, allowing them to remain together long enough for actual insemination to take place. Heape, and Dubreuil and Regaud, on the contrary, find that if, in this animal, pairing for any reason does not occur during the oestrus period, the eggs which would naturally have been discharged all degenerate within the ovaries. Indeed, according to Heape, if the male is withheld from the doe during several consecutive periods of oestrus, most, if not all, of the older and many of the younger follicles undergo degeneration, and this may result in a more or less permanent sterility.

Marshall ('03 and '04) has studied the oestrus cycle in the sheep, and in the common ferret. He states that Scotch black-faced ewes can, during the regular sexual season, ovulate without pairing, as claimed by Bischoff ('44) for ewes in general, but pairing, according to Marshall, even then may hasten the process of ovulation, which outside of such rutting periods may be dependent upon copulation. The common ferret, Marshall finds, behaves as recent investigators have found to be the case with the rabbit, ovulating only after pairing. The withholding of the male greatly prolongs the period of heat, and in a few exceptional cases is said to lead to the death of the female.

Benecke ('79), Eimer ('79), Fries ('79), Van Beneden and Julin ('80), and Van Beneden ('99) are all agreed that in all the various species of bats that they have studied, pairing takes place several weeks before the eggs leave the ovaries.

The condition of affairs in mice has been disputed by Sobotta ('95 and '07) and Kirkham ('07), who have claimed the inde-

pendent occurrence of ovulation and pairing, by Gerlach ('06), who denied such independence, and by Lams and Doorme ('07), who state that ovulation in the mouse is perhaps connected with pairing.

Bischoff ('44) did a little work with rats, and he came to the conclusion that in them ovulation could take place without pairing, but he confessed that his evidence was incomplete.

In view of these uncertain and conflicting statements, it has seemed desirable to submit the matter of the relation, if any, between ovulation and pairing, to a critical test in the case of the rat and the mouse, using, in some instances, individuals that had been isolated from as early a period as the sex could with certainty be externally determined. The four female white mice used were virgins from two litters, by different parents, and were kept apart from all males, including their brothers, from the time they were two weeks old. Three of these females were born in the laboratory in the middle of December, 1908, and the other early in January, 1909, and all four, until they had been weaned, were isolated with their respective mothers.

One of the virgins born the previous December was chloroformed on March 19, 1909, a day selected by chance, without any special calculation other than the general knowledge that the mice born about the same time as the test animals were beginning to show signs of pregnancy. When the body of this animal was opened, and the ovaries examined, bright red spots were found upon both these organs, a characteristic sign that ovulation had recently occurred. The ovaries and Fallopian tubes were then removed from the body, and serial sections were prepared in a manner described in a previous paper (Kirkham '07). The study of this material has revealed seven eggs in the Fallopian tubes, beside numerous eggs still in the ovaries, the latter undergoing degenerative changes after having formed the first polar body and second polar spindle. The tube eggs appear in every respect like those obtained from females which had paired, and were then killed before the spermatozoa had reached the eggs. A varying number of follicle cells are found associated with the eggs, the zona pellucida in all cases is sharply defined, all the eggs possess second polar spindles, and in two instances the first polar body is still visible, although decidedly atrophied.

The remaining three virgin mice were killed March 30, 1909, and of those born in the preceding December, the Fallopian tubes of one yielded nine eggs, similar to those mentioned above, except that seven still showed first polar bodies; the ovaries of the other animal had upon them the white scars indicative of well formed corpora lutea, and no sign of eggs was found in either Fallopian tube. Both sets of ovaries contained a number of mature eggs undergoing degeneration. The female mouse born in January showed no signs of having ovulated, no evidence of either young or old corpora lutea being found on either ovary, nor any trace of eggs in the Fallopian tubes. The ovaries of this animal, however, have in them several eggs with first polar bodies and second polar spindles, but all appear to be degenerating.

From these observations we may safely conclude that not only is ovulation in adult female white mice independent of pairing, as stated by Sobotta ('95 and '07), and by the writer ('07), but that it is an independent process from the start, maturation and ovulation occurring in the females without regard to pairing, although at present we do not know with what regularity.

These results, also, are not only of general interest, but they possess value as showing the mouse to be an eminently suitable mammal upon which to investigate the possibility of artificial parthenogenesis.

A further fact which should be noted here, is the change of opinion, on the part of the writer, regarding the fate of the first polar body formed by the mouse egg. In 1907 the writer stated that his observations led him to believe that when the first polar body was not found with the egg, it had been forced through the zona pellucida at the time of ovulation. That same year Lams and Doorme ('07) published a paper on the development of the mouse egg in which they stated that the first polar body in that animal underwent degenerative changes leading finally to its disappearance. These authors figured a few first polar bodies in an advanced state of atrophy, and the present writer has since confirmed their conclusions, using some material of his own obtained since the publication of his first statement on the subject. A fairly complete series of degenerating first polar bodies — some

belonging to eggs themselves degenerating within the ovaries, others in the process of early cleavage in the Fallopian tubes — make it practically certain that in the case of such mouse eggs as have reached or passed the stage when the second maturation spindle is formed, and yet show no trace of the first polar body, this body has broken up and disappeared; in all instances of such degeneration the chromatin granules lose their distinctive staining qualities some time before the final dissolution of the polar body cytoplasm.

The observations on rats were limited to two adult white females. These animals were kept in a large cage with males and other females until they showed signs of advanced pregnancy. They were then isolated in separate cages, and a close watch was kept for the appearance of the litters. As soon as found, the young rats were taken from their mothers, and then the latter were killed, one twenty-four, the other forty-eight hours later; it having been previously determined that the white rat, like the white mouse, during the warm months of the year is usually in heat directly after giving birth to a litter. When the bodies of these animals were opened, characteristic corpora lutea were visible on all the ovaries, and after the ovaries and Fallopian tubes had been sectioned and stained, eight tube eggs were found in one animal, and five in the other. These eggs have exactly the appearance of eggs obtained from female white rats which have been allowed to pair and then are killed just before fertilization can take place; the zona pellucida in all cases is well preserved, all of the eggs possess second polar spindles, while a majority show no trace of the first polar body, it probably having previously degenerated.

The points to be emphasized in these researches are three in number:

1. Virgin white mice mature eggs and discharge them from their ovaries at practically the same age as their sisters who have been allowed to pair, and such eggs show no differences from other unfertilized eggs.

2. Adult female white rats during the active breeding season ovulate regularly, immediately after giving birth to a litter, whether pairing is or is not allowed to take place.

3. The first polar body has degenerated in such mouse and rat eggs as show no trace of it, and yet have reached or passed the stage of the second maturation spindle.

SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY,
March, 1910.

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DESCRIPTION OF AN ABNORMAL LOBSTER CHELIPED.[1]

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While visiting the United States Fish Hatchery at Gloucester, Mass., during the summer of 1908, my attention was called to an abnormal lobster (*Homarus americanus*) which was at that time preserved in formalin. The specimen was taken in Gloucester harbor by a local fisherman in the preceding May, and was kept alive in an aquarium at the hatchery about a week before it died. Through the kindness of Mr. Corliss, superintendent of the hatchery, I was enabled to secure the specimen for description. The abnormality consists of a double extra claw on the left cheliped, and while not different in general type from specimens which have previously been described, it does possess certain peculiarities which would appear to justify placing it on record. The right cheliped was missing when the lobster was caught. From the appearance of the scar, and the fact that there is no evidence of regeneration having begun, it is probable that the loss of the appendage was comparatively recent. The especial interest of the present specimen lies in the fact that the extra claws are so well developed and that their arrangement is almost schematic of the principles, or "rules" of secondary symmetry laid down by Bateson (**1894**, p. 479), if we make allowance for the torsion which normally occurs in the cheliped of the lobster.

DESCRIPTION.

The lobster possessing this abnormality is a male, 237 mm. in length from tip of rostrum to end of telson.

Claws.—The part which represents the primary claw (*PrL* of figures) is practically a normal left chela of the *crushing* type, except for an abnormal outgrowth from its outer (morpho-

[1] Paper from the Zoölogical Laboratory, Sheffield Scientific School of Yale University.

logically posterior) face. This outgrowth does not arise from the middle of the outside face of the primary propodus, but rather from the ventral half of its surface, the significance of which in its relation to the planes assumed by the various claws will be discussed further on. In general appearance the outgrowth represents a more or less completely doubled extra claw,[1] and according to the classification given by Emmel (**1907**) would fall in the class having "abnormal processes arising from the normal propodite," and under this heading it would probably have to be classed with those having "two extra indices and double extra dactyl." It differs, however, from any previously described specimens in this category, so far as I am aware, in the degree to which the double dactyl approaches the condition of two separate dactyls, it being markedly bifurcated at the tip, whereas in the case (specimen No. 4) described by Emmel, what he takes to be the double dactyl is only a small undivided "stump." The strength of his interpretation lies in the fact that both the double dactyl and the index in other specimens may be represented by an undivided process, the double character of which is indicated by its having teeth on two opposite sides (cf. Emmel's specimens No. 2 and No. 3).

Considering now only the supernumerary outgrowth, the basal part, which represents a double propodus, has along its ventral side a deep groove, as may be seen in Fig. 2. The continuation of the divergent ridges which bound this groove form two separate and distinct indices ($I'R$ and $I'L$), each of which, taken by itself, appears like a practically normal index. They are, moreover, essentially alike except that their relations of symmetry are reversed, so that one would appear as the image of the other in a plane mirror placed between them. This relation will, however, be discussed more fully later. The opposing dactyl is also divided for nearly half its length, on account of the bifurcation mentioned above, the divergent branches ($D'R$ and $D'L$) meeting in opposition the corresponding extra indices ($I'R$ and $I'L$). The double character of the dactyl clear to its base is indicated by the fact that the rows of teeth on the two tips continue in separate and distinct lines down the inside of the basal portion. Further-

[1] The extra claws are somewhat smaller than the normal or primary claw.

more, on the dorsal side near the base, the single spine of the primary dactyl ($SpDL$) is represented by two similar spines ($SpD'R$ and $SpD'L$). The row of spines down the dorsal ridge of the extra propodite is very weak, whereas there is a row of strong spines in the corresponding position on the normal propodite (PrL). This is a result of the "compounding" at this level, to be mentioned again below (p. 264).

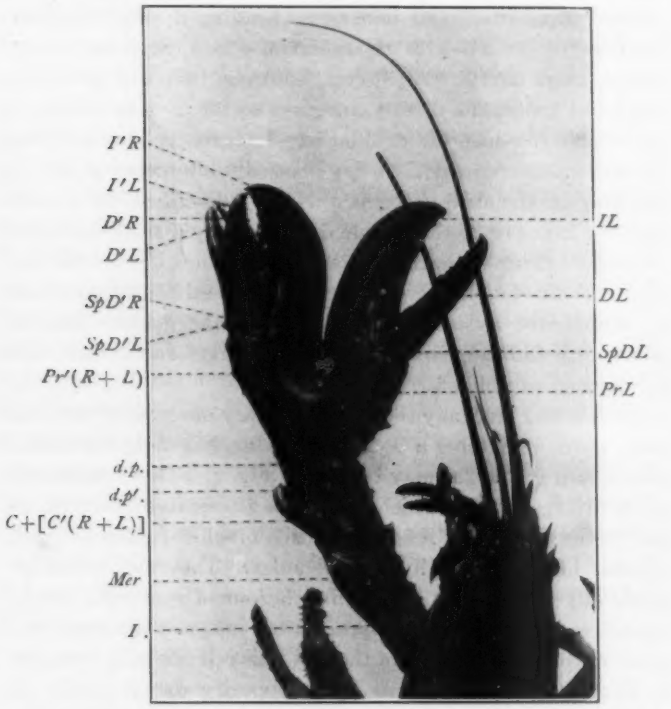

FIG. 1. Photograph of abnormal chelped from dorsal side. (For explanation of abbreviations used in the figures see list on p. 267.)

The distance between the tips of the two diverging extra dactyls ($D'R$ and $D'L$) is very slightly greater than that between the tips of the two extra indices ($I'R$ and $I'L$), so that if the double dactyl closed down squarely it would tend to make the tips lap

over on the outside (morphologically dorsal side) of each of the index tips; but, as may be seen in Fig. 1, they do not close squarely, but instead the double claw shuts in such a manner that *both the dactyl tips overlap the index tips on the side toward the normal (primary) claw.* Thus $D'L$ overlaps on the *ventral* side of $I'L$, and $D'R$ on the *dorsal* side of $I'R$. In this connection it

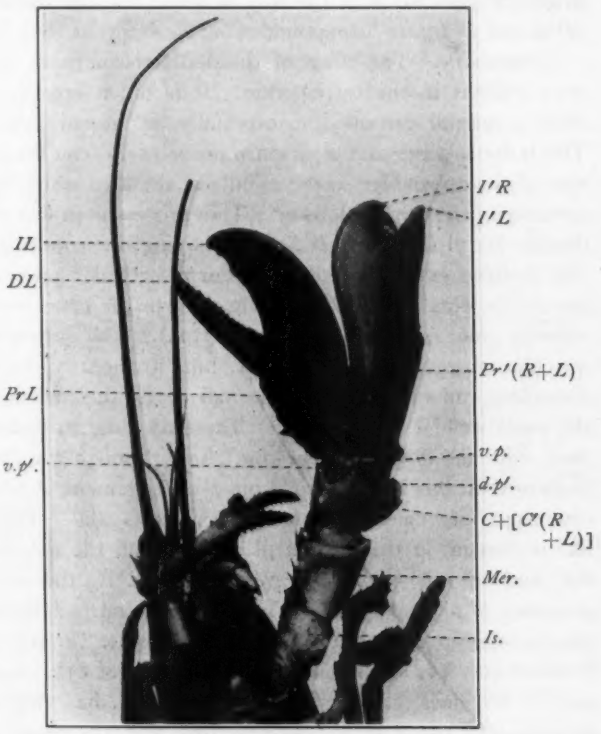

FIG. 2. Photograph of abnormal cheliped from ventral side.

is interesting to note that the normal dactyl (DL) when closed overlaps decidedly on the ventral side of its index (IL), that is, on the side away from the extra claws. All these dactyls thus overlap their respective indices on the side toward the median plane of the animal, in this matter not agreeing with the morpho-

logical symmetry which obtains in other respects. As is to be expected the teeth on the extra claws are plainly, like those of the normal claw, of the "crusher" type.

No attempt was made to study the internal anatomy further than to note that the extra double dactyl has *two* adductor tendons, but only a single abductor tendon. This condition is what might be expected from the way in which the two extra dactyls ($D'R$ and $D'L$) are "compounded" (*vide infra*) at their base.

Carpopodite.—The effect of the doubled condition distally is very evident in the carpopodite. It is much broader distally than a normal carpopodite, especially as viewed from above. This is due in large part to an extra process (*d.p'.*) on the posterior face of the appendage in the middle of the area which is evenly concave in the normal lobster. This process is in line with the double dactyl ($D'L$ and $D'R$), thus having the same relations to this doubled extra part that the dorsal articular process (*d.p.*) has to a normal dactyl. Opposite *d.p'.*, in the concavity of the anterior side, is a smaller process (*v.p'.*). The normal ventral articular process (*v.p.*) is present, but, apparently due to the disturbing influence of the abnormal parts, the articulation of the chela with it is not close.[1] The only close articulation is, then, with the dorsal process (*d.p.*), and although the chela can be moved on this in the normal plane of movement, it is capable of a slight movement in other directions as well. The hinge-like movement in the normal plane (*i. e.*, on the axis between *d.p.* and *v.p.*) is, moreover, greatly limited by the secondary processes (*d.p'.* and *v.p'.*). Whereas in the normal lobster the claw (propodite) can swing on the carpopodite through an arc of about 90°, it is limited here to a movement of 25°. A smooth spot on the shell (*x*, Fig. 3) shows where *d.p'.* has stopped the movement of the claw in that direction, and the nature of the surfaces at *v.p.* shows that in the living animal there must have been some movement of the claw in the plane at right angles to the normal plane of movement.

[1] It would look as though the presence of muscles belonging to the abnormal part, which by their action tended to swing the claw on the secondary axis *d.p'.*–*v.p'.*, had prevented a close articulation at *v.p.* A careful study of the musculature of the carpopodite would be of much interest, but it was found impracticable to make such a study at the present time.

The arrangement of certain of the spines also goes to show that *d.p'.* is to be considered as the equivalent of a double dorsal articular process corresponding to the doubled abnormal claw; but there is no need to go into the details of this matter, which can be made out in the figures.

Meropodite.—Here, too, the abnormality is evident. The joint is relatively much thicker than the corresponding joint in a

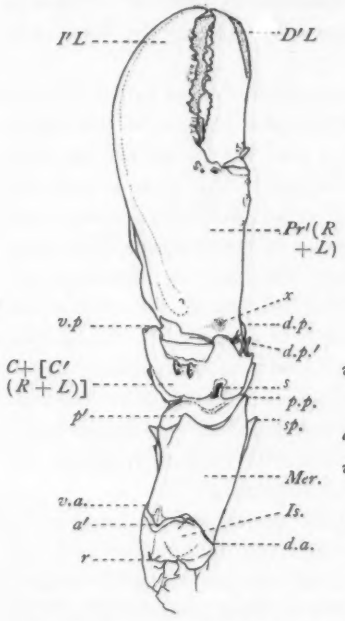

FIG. 3. Abnormal cheliped seen from posterior side (really a little ventro-posterior).

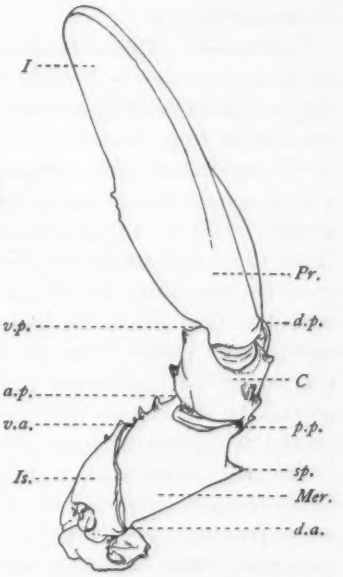

FIG. 4. Normal left cheliped of a lobster, seen from posterior side (really a little ventro-posterior).

normal lobster. The normal plane of articulation between the meropodite and the carpopodite is morphologically horizontal, the articular processes therefore being anterior (Figs. 3 and 4, *a.p.*) and posterior (*p.p.*). These processes and the articulation are essentially normal in the abnormal claw, but in the concavity of the (morphologically) ventral side is a large process (*p'*) which apparently represents one point for an incipient axis of articu-

lation in a plane at right angles, or nearly so, to the normal articulation. This condition corresponds to that between the carpopodite and the propodite, described above. There is no evidence of the corresponding process on the opposite side, however, nor is there any articulation with *p'*, the distal portion swinging normally on the axis between *a.p.* and *p.p.* But while this movement covers an arc of approximately 45° in a normal claw, it is here limited to a range of between 25° and 30°. There is no sign of duplication of the large spine (*sp.*) on the dorsal side of the meropodite.

Ischiopodite.—The ischiopodite, instead of being broad and flat, as in normal cases, is broadly triangular in cross section, while the line of articulation between it and the meropodite is much less oblique than normal. The motion at this place is normally (in the legs following the cheliped) on an essentially dorso-ventral axis (*d.a.–v.a.*), though due to torsion in the chelipeds it becomes greatly inclined. In the abnormal specimen the dorsal articulation (*d.a.*) appears practically normal, but on the ventral side there are two points of articulation (*v.a.* and *a'.*). Being thus hinged at three places the joint is stiff and incapable of movement in any plane. The row of spines running down the ventral side of the meropodite and continued on the ischiopodite, proves the articulation (*v.a.*) in line with these to represent the normal one, while the other (*a'*) is secondary.

The articulation between the ischiopodite and the basal podomeres is apparently normal, though the ischiopodite here has on its posterior side a ridge (*r*) which is not present in normal specimens. This ridge ends in a short, blunt process, much like an articular process, but there is no articulation with it. It does in all probability, however, represent such a secondary process, being placed, as in the other joints, midway between the normal points of articulation.

Relations of Symmetry.

Torsion.—It is a matter of common knowledge that in development the cheliped of the lobster undergoes a twisting or torsion, as a result of which the chelæ come to lie in a nearly horizontal plane, that is, almost at right angles to their normal

morphological plane. This is illustrated in Fig. 5. This figure represents diagrammatically a cross section through the index and dactyl of a normal claw from the left side of a lobster, viewed from the position of the distal end of the appendage. The posterior side of the claw, which is more darkly pigmented in the living lobster, is here shaded, while the ventral side is left clear. The primary morphological relations, as they would obtain if the appendage were extended laterally in a horizontal

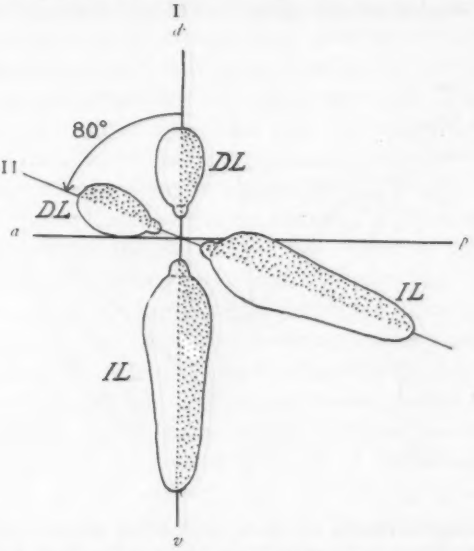

FIG. 5. Diagram to illustrate effects of torsion in a normal left chela. I., primary morphological position; II., position as a result of torsion.

plane and there were no torsion, are shown in the position marked I, where the plane passing through the index (*IL*) and dactyl (*DL*) is vertical. Due to torsion, however, the claw is rotated anteriorly[1] nearly 90° (probably ordinarily 75°–80°; for convenience, we may call it 80°), so that its plane approximates the horizontal, as shown in position II. The dactyl thus lies anteriorly, while the posterior surface (shaded) is uppermost. By a bending of the leg now, however, the claws may be brought

[1] By "rotated anteriorly" it is meant that the *dorsal* side has rotated over in the *anterior* direction.

around into the position in which they are normally carried, that is, ahead of the lobster and pointing forward or even inward. As a result the dactyl comes to lie on the side toward the median plane, or even directed posteriorly. The primary claw in Figs. 1 and 2 has nearly the normal position, but as will be pointed out below, the torsion and bending are less than is usual. Emmel (**1907**, p. 140) has emphasized the importance of taking into account the normal torsion in considering the relations of supernumerary parts in abnormal chelipeds.

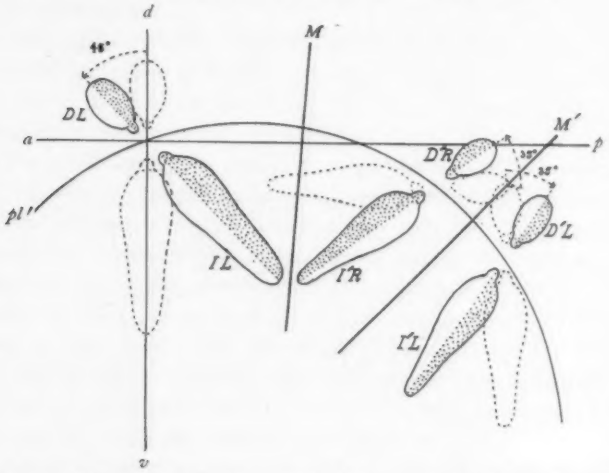

FIG. 6. Diagram showing the spacial relations and secondary symmetry in the abnormal cheliped (full outlines). The dotted outlines show the theoretical relations these parts should have in accordance with the "rules of secondary symmetry," leaving torsion out of account.

In Fig. 6, by a similar diagram, are represented the conditions, as regards rotation, of the three claws of the abnormal specimen. As before, the appendage is considered as being extended straight out laterally from the body. It will be noted that as a result of the abnormal outgrowth the primary claw (*IL*, *DL*) has rotated only about 45° from the vertical plane instead of nearly 90° as in the normal (Fig. 5). The amount of torsion in the abnormal chelæ will be discussed below with the consideration of the relations of right and left. It may be said here, that as

in the case of the claw, the torsion of the more proximal parts of the limb appears also to have been hindered by the abnormality.

Secondary Symmetry: Dextro-sinestral Relations.—Like most abnormal crustacean appendages with extra processes, the present case falls into the category "in which the extra limb or extra parts of a limb are themselves morphologically double." Furthermore, in accordance with the rules of secondary symmetry laid down by Bateson (**1894**, p. 479), the normal appendage and the extra parts lie in the same plane[1] and "the nearer of the two extra appendages is in structure and position formed as the image of the normal appendage in a plane mirror [*M*, Fig. 6] placed between the normal appendage and the nearer one, at right angles to the plane of the three axes; and the remoter appendage is the image of the nearer in a plane mirror [*M'*, Fig. 6] similarly placed between the two extra appendages." Thus the two extra claws are morphologically a pair and belong to opposite sides of the body, the inner or proximal one, according to the above rule, being a morphological right (the primary claw being a left), and the outer one a left. This is evident in the diagram (Fig. 6), where it will be noticed by the shading that the relations of the posterior (shaded) and anterior (not shaded) halves are reversed in the middle claw. In one respect, however, the middle claw is not a right; for the normal right claw of this lobster was in all probability of the "nipper" type, the left being a "crusher." As a matter of fact the teeth on both the indices and dactyls of all three of the claws of the abnormal appendage (*IL*, *DL*; *I'R*, *D'R*; *I'L*, *D'L*) are of the "crusher" type. Thus it is evident that while the rules of secondary symmetry hold good for the *spatial relations* they do not apply to the *character* of the parts of the appendage when these normally differ on the two sides of the animal.[2]

Bateson (**1894**, p. 479, *et seq.*) has shown that a definite relation obtains between the position which the extra parts assume to each other and to the primary appendage, according to the side of the appendage from which they arise. The theoretical positions he has illustrated plainly by means of a diagram (*loc.*

[1] This plane (Fig. 6, *pl'*.) is bent in the present case, owing to torsion. See later.

[2] Emmel (**1907**, p. 110) found the same thing to be true in his "specimen No. 5."

cit., Fig. 154) of the leg of an insect, and most of the cases fit in with these expectations very well.

Adapting to the lobster Bateson's diagram for the theoretical positions of the extra parts when they arise from the ventro-posterior (*v.p.*) side of the normal appendage, as in the present case, we have the relations as shown by the complete outlines

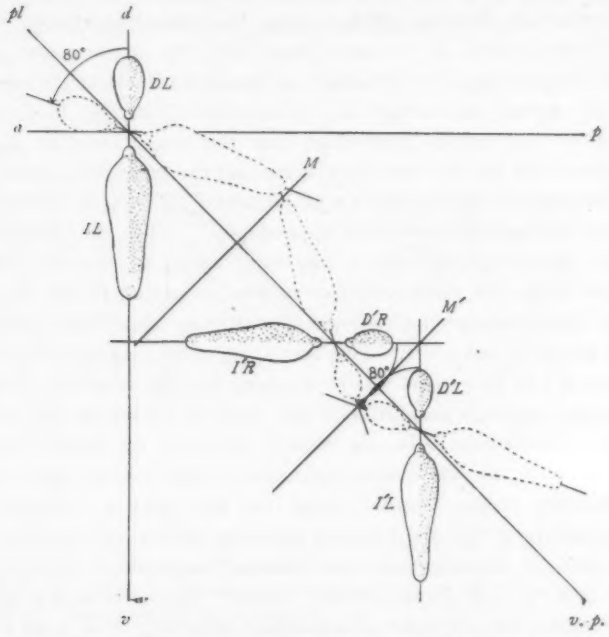

FIG. 7. Diagram illustrating (full outlines) Bateson's "rules of secondary symmetry" as applied to a left lobster chela with double extra claws arising from the ventro-posterior side. The dotted outlines show the positions these parts would assume if each claw were rotated anteriorly, independent of the others, through an arc of 80°.

in Fig. 7, no allowance being made for torsion. But we have seen (*p.* 259) that the normal lobster claw becomes rotated anteriorly through an arc of approximately 80°. If we now rotate independently toward its anterior side each of the diagrammatic claws in Fig. 7 through an arc of 80°, we arrive at the posi-

tions indicated by the dotted outlines in the same figure. Referring now to Fig. 6, which represents (by the unbroken outlines) the actual positions of the claws, we find that whereas the primary claw has rotated in the expected direction—though only about 45° instead of 80°—the secondary claws appear each to have rotated towards their morphological *dorsal* sides about 35° from the planes prescribed in the theoretical diagram (Fig. 7, full outlines). These relations are perhaps to be accounted for as follows:

While there is some torsion in the base of a normal cheliped, this is compensated for by the rotation of the appendage forward, as a result of which the axis of articulation at the base of the propodite, which is morphologically dorso-ventral, is essentially vertical, as it is in the succeeding pereiopods. Hence the position of the great claw is for the most part due to a *torsion in the propodite itself*. In our abnormal specimen, the axis of articulation of the propodite to the carpopodite lies also, as we have seen, practically in a vertical plane; but, apparently as a result of the mechanical hindrance of the secondary growth from its base, the primary propodite has been able to turn only 45° instead of 80° from that plane.

The positions assumed by the secondary claws are a little more difficult of explanation. Since, however, they have a tendency to rotate in opposite directions, the plane (M') midway between them should remain constant in position whatever the amount of torsion, as shown in Figs. 6 and 7, and we may first consider the relation of this plane to that of the primary claw. By reference to Fig. 7 we see that this plane, in the case of a double extra process arising from the postero-ventral surface of an appendage, should make an angle of 45° with the dorso-ventral plane (*d.–v.*). A glance at Fig. 6 will now show that the plane M' there makes the same angle (45°) with the primary dorso-ventral plane of the abnormal specimen. As a result, however, of the torsion distad of the point of divergence, the three claws no longer lie in the same plane (*pl.*, Fig. 7) which passes through the point of origin of the extra parts, but a line connecting their centers has to curve as shown by *pl'.* in Fig. 6.

We have already noted that the planes of the secondary

claws lack 35° of being turned as far as called for by the theoretical positions (solid outlines, Fig. 7), to say nothing of the additional 80° which would be necessary for them to assume the positions as a result of normal torsion (dotted outlines, Fig. 7). As a matter of fact, this torsion should *not* be expected in the secondary claws, since they divide from each other at a considerable distance from the base, and the torsion of the propodite takes place entirely, or practically so, at its base. There would be no torsion in the basal part of the extra outgrowth, since in that region which is potentially double, the tendencies to rotation in opposite directions would neutralize each other. The divergence of the primary claw being further proximal, that has been able to undergo some rotation (45°) as already described. Now as to the failure of the planes of the secondary claws to lie at right angles to each other, as they should, according to Fig. 7, if torsion is eliminated. This is probably to be accounted for upon mechanical grounds, the union of the parts only a short distance proximad interfering with and restricting the divergence of these planes. If the double outgrowth had taken its origin upon a more basal portion of the appendage, it is safe to assume that the planes of the distal claws would have attained more nearly the theoretical positions.[1]

The relations of secondary symmetry in the more proximal parts of the appendage appear to be amenable to the same rules; but owing to the way in which the various parts are "compounded" (to use Bateson's term) before they actually divide, this exposition becomes extremely complicated and would serve no useful purpose at this time, since the discussion given above as to the relations of the claws has served to illustrate the factors involved. This compounding accounts for the absence of large spines along the dorsal side of the extra propodite, which has already been mentioned.

[1] In Emmel's interesting "specimen No. 5" the extra chelæ arose from the meropodite, and he here found (the union being further proximad) that each of the claws had undergone a full rotation, each in its normal direction of torsion. According to his description (Emmel, **1907**, p. 141) the primary or normal claw had rotated 90°, but *each of the extra claws had rotated* 180°! Why this should have been seems difficult to understand and Emmel offers no explanation. Why, with the direction of torsion opposed in contiguous claws, its amount should be limited to less than 90°, as in the specimen here described, is obvious; but why in any case it should be *greater* than 90° seems inexplicable.

Cause of the Abnormality.

While believing that we must ultimately look to experiment for the elucidation of the causes of abnormalities of this sort, there are nevertheless certain considerations in the present instance which are of interest. On the theory that they may be the result of injuries, marks indicating such injury have often been sought. The scar of an evident injury is very noticeable on the carpopodite of the present specimen (Fig. 3, *s.*); but is is equally evident that this injury cannot have been the the cause of the abnormality, since, as we have seen, the effect of the doubling is obvious as far proximad as the ischiopodite. It seems more probable that after some antecedent autotomy of the appendage the regenerating bud was in some way injured or disturbed so as to produce the abnormality. A definite scar for such an injury could not be expected in the fully developed appendage. Not only would it be of the greatest importance to know whether this abnormality would be reproduced if the leg could have been amputated autotomously and allowed to regenerate (cf. Emmel, **1907**, p. 111), but it would also be interesting to know whether a lobster could moult normally with an appendage of this sort. On account of the extra amount of material involved, which would have to be drawn through the narrow opening at the base of the leg, it would certainly be a much more precarious ordeal than usual.

Summary.

In this paper is described the abnormal cheliped of a lobster (*Homarus americanus*), the abnormality consisting of a double extra claw. While the extra part actually separates from the normal propodus, it is shown that the effects of the doubling may be traced to the base of the leg. It is further shown that the conditions in this appendage illustrate almost diagrammatically the "rules of secondary symmetry" formulated by Bateson, if allowance be made for the effects of the torsion which occurs in the normal lobster cheliped and the mechanical conditions which may modify such torsion.

ADDENDUM.

Since it is of advantage to place on record where they may be found the cases of abnormal crustacean appendages, it may be well to call attention here to two recent records which might naturally be overlooked. They both occur on crabs, and both belong to the class of "extra processes arising from the normal dactyl," being directly comparable to the chelæ figured by Emmel (**1907**, pl. 1, Fig. 1), Faxon (**1881**, pl. 1, Figs. 1, 2, 3, 4, 5, 7, 8), Herrick (**1895**, pl. 47, Fig. 191), and Bateson (**1894**, Figs. 184, 185).

The first case is fiured incidentally by Verrill (**1908**, p. 396, Fig. 37) in his report on the "Decapod Crustacea of Bermuda."

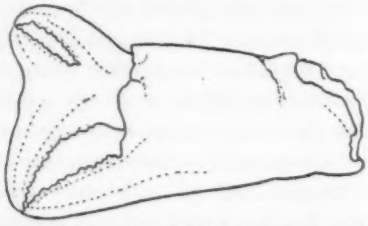

FIG. 8. Deformed claw of an undetermined cancroid crab. (After Verrill.)

Fig. 8 represents the condition of this specimen, which is described as the "deformed claw of an undeterminal cancroid crab."

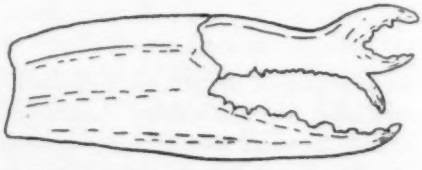

FIG. 9. Abnormal crab claw from Stonington, Conn. (After Leavitt.)

The second case (Leavitt, **1909**), illustrated in Fig. 9, is of a crab, possibly *Callinectes*, from Stonington, Conn. The author states that there was a brief mention of this claw in *St. Nicholas* for December, 1907. He makes the mistake of considering this a reduplication of the entire claw, except that "in the small pincer the dactyl is not movable at the base, as it is in the larger

one." Further, he calls it a case of "homœosis" and gives a general consideration of it in relation to Weismannism, etc.

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Explanation of Abbreviations Used in Figures.

a., anterior.

a'., secondary point of articulation of ischiopodite to meropodite.

a.p., anterior articular process of meropodite.

C., carpopodite.

$C+[C'(R+L)]$., carpopodite of abnormal specimen, compounded of the primary and secondary parts.

d., dorsal.

d.a., primary (normal) dorsal articulation of ischiopodite to moropodite.

DL, left primary or normal dactyl.

D'L, left extra dactyl.

d.p., primary (normal) dorsal articular process of carpopodite.

d.p'., extra (secondary) dorsal articular process of carpopodite.

D'R., right extra dactyl.

I, index.

IL, left primary or normal index.

I'L, left extra index.

I'R, right extra index.

Is, ischiopodite.

M, line representing position of a plane mirror placed midway between the primary claw and the nearer secondary claw, and normal to the plane in which they lie.

M', line representing position of a plane mirror placed midway between the extra claws and normal to the plane in which they lie.

Mer., meropodite.

p., posterior.

$\not{p}'$., process representing an incipient secondary articular axis between meropodite and carpopodite.

$\not{p}l$., plane passing through the point of origin of the secondary growth from the primary claw and through both the extra claws.

$\not{p}l'$., curved line representing the bending of the plane $\not{p}l$. as a result of torsion and the mechanical conditions.

$\not{p}\not{p}$., primary (normal) posterior articular process of meropodite.

Pr., propodite.

$Pr\,L$, left primary or normal propodite.

Pr' $(R+L)$, extra double propodite.

r., ridge at base of ischiopodite, possibly representing a secondary incipient point for articulation with basal podomeres.

s., scar on base of abnormal carpopodite.

$s\not{p}$., large spine on meropodite.

$S\not{p}D\,L$, spine at base of primary or normal dactyl.

$S\not{p}D'\,L$, spine belonging to base of left extra dactyl.

$S\not{p}D'R$, spine belonging to base of right extra dactyl.

v., ventral.

$v.a$., primary (normal) ventral articulation of ischiopodite to meropodite.

$v.\not{p}$., primary (normal) ventral articular process of carpopodite.

$v.\not{p}'$., extra (secondary) ventral articular process of carpopodite.

$v.-\not{p}$., ventro-posterior, the side of the primary claw from which the extra claws arise.

x., smooth spot where the secondary dorsal articular process ($d.\not{p}'$.) of the carpopodite has rubbed against the base of the propodite.

I., position before torsion.

II., position as a result of torsion.

METHODS OF ARTIFICIAL PARTHENOGENESIS.

E. NEWTON HARVEY.

Papers on the subject of artificial parthenogenesis have been fairly abundant during the past ten years, yet somewhat scattered, appearing in zoological, physiological and chemical journals. It therefore seemed desirable to list the important contributions, giving briefly, but in detail, the various methods of exciting eggs to develop, together with results and references, in the hope that it might prove of value to future workers.

Such a list follows. Only annelids, echinoderms, molluscs and vertebrates have been included. Under each class the observers are arranged in alphabetical order; their researches in chronological order.

As the most important general and theoretical work on artificial parthenogenesis may be mentioned the recent book of Loeb, "Die Chemische Entwicklungserregung des tierischen Eies," Berlin, 1909, in which the various phases of this most interesting subject are discussed in considerable detail.

The following abbreviations have been used:—

s. w. sea water.	*dist. w.* distilled water.
m. molecular solution.	*P. B.* polar bodies.
n. normal solution.	*esp.* especially.
min. minute.	*P. D.* potential difference.
hr. hour.	

ANNELIDS.

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Ophelia.	Hypertonic sea water (20 c.c. 2.5 m. KCl+80 c c. s.w. for 2 hrs. at 18°).	To s.w. Swimming larvæ.	60	Bullot, G.	*Arch. Entwm.*, XVIII., p. 161, 1904 and *U. Calif. Pub. Physiol.*, I., p. 165, 1904.
Amphitrite.	Hypertonic sea water (98 c.c. s.w.+2 c.c. 2.5 m. Ca $(NO_3)_2$ for 30 min.),	To s.w. Trochophores.		Fischer, M. H., at Woods Hole.	*Am. J. Physiol.*, 7, p. 301, 1902.
"	Calcium ions (98 c.c. s.w.+2 c.c. m. Ca salt).	Permanently. Mg, Li and Na cause no development.		Fischer, M. H., at Woods Hole.	*Am. J. Physiol.*, 7, p. 301, 1902.
"	Mechanical agitation.			Fischer, M. H., at Woods Hole.	*Am. J. Physiol.*, 7, p. 301, 1902.
Nereis.	Hypertonic sea water by NaCl, KCl or cane sugar (17.5 c.c. 2.5 m. KCl+82.5 c.c. s.w. for 1 hr.).	To s.w. Swimming larvæ.		Fischer, M. H., at Woods Hole.	*Id.*, 9, p. 100, 1903.
Thalassemae mellita.	Acids (mineral, fatty, dibasic organic and CO_2).	To s.w. Trochophores.	6	Lefevre, G.,	*Journ. Exp. Zool.*, IV.,
	17 c.c. *m*/10 HNO_3+83 c.c. s.w. for 5 m.		to	at Beau-	p. 90, 1907.
	15 c.c. *m*/10 HCl+85 c.c. s.w. for 5 m.		60	fort, N. C.	
	10 c.c. *m*/20 H_2SO_4+90 c.c. s.w. for 8 m.				
	12 c.c. *m*/20 $(COOH)_2$+88 c.c. s.w. for 8 m.				
	15 c.c. *m*/10 CH_3COOH)+85 c.c. s.w. for 5 m.				
	CO_2 from generator to s.w. for 10 m. and eggs immersed 1 hr.				
Chætopterus.	KCl sea water (10–20 c.c. 2.5 *n* KCl+90–80 s.w. for 1 hr.)	Confirms Loeb.		Lillie, F. R.	*Arch. Entwm.*, XIV., p. 477, 1902.
Chætopterus, Phascolosoma, Podarke.	Hypertonic sea water (15–20 c.c. 2.5 *n* NaCl +85 c.c. s.w. for 1 hr.).	To s.w. " swimming larvæ."		Loeb, J., at Woods Hole.	*Am. J. Physiol.*, IV., p. 423, 1901, and *Science* XII., p. 170, 1900.
Chætopterus.	Potassium ions (10 c.c. 2.5 *n* KCl+90 c.c. dist. w. for 7 m.			Loeb, J., at Woods Hole.	*Am. J. Physiol.*, IV., p. 423, 1901, and *Science*, XII., p, 170, 1900.

ANNELIDS.—*Continued.*

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Chætopterus.	Acids (100 c.c. s.w.+1–2 c.c. HCl and left permanently).	Segmentations.	Small	Loeb, J., at Woods Hole.	*Amer. J. Physiol.*, IV., p. 423, 1901, and *Science*, XII., p.170,1900.
Polynoë, Sipunculus.	Alkalies (50 c.c. s.w.+1.5 c.c *n*/10 NaOH) permanently or 5–6 hrs.	To s.w. Larvæ.	30 30	Loeb, J.	*Pflüger's Archiv*, 118, p. 572, 1907, and *U. Calif. Pub. Phys.*, 3, p. 71, 1907.
Polynoë.	Alkali (dilute) for 4 hrs.	50 c.c. 5/8 m. Vant' Hoff's sol.+10 c.c. 2.5 m. NaCl for 2 hrs.			*U. Calif. Pub. Phys.*, 3, p. 71, 1907.
"	Saponin and solanine (15 drops weak sol. in 4 c.c. s.w. for 1–1.5 min.)	To s.w. Larvæ.	Most	Loeb, J.	*Arch. f. d. ges. Physiol.*, 122, p. 448, 1908.
Amphitrite.	Hypertonic sea water, Ca ions and Mechanical Agitation.	Confirms Fischer.		Scott, J. W., at Woods Hole.	*J. Exp. Zool.*, 3, p. 62, 1906.
Podarke.	Hypertonic sea water (20 c.c. 2.5 KCl+80 c.c. s.w. for 1 hr.).	To s.w. swimming larvæ.		Treadwell, A. L., at Woods Hole.	BIOL. BULL., 3, p. 235, 1902.

HOLOTHURIANS.

Holothuria tubulosa.	Acids (3 c.c. *m*/10 HCl+100 c.c. s.w. for 5 min.).	To s.w. Segmentations but no larvæ.		Lyon, E.P. at Naples.	*Am. J. Physiol.*, IX., p. 308, 1903.

MOLLUSCS.

Egg of	Preliminary Treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Mactra.	Hypertonic sea water (5–15 c.c. 2.5 *n* KCl, NaCl, $CaCl_2$ to 85–95 c.c. s.w. for .5–2 hrs.). Concentrated (by evap.) s.w.	To s.w. Segmentations.		Kostanecki, K., at Naples.	*Arch. f. micros. anat.*, 64, p. 1, 1904, also *id.*, 72, p. 327, 1908.
Lottia gigantea.	Hypertonic sea water (15–20 c.c. 2.5 *m* KCl to 100 c.c. s.w. for 2 hrs.).	To s.w. Swimming larvæ.		Loeb, J., at Pacific Grove.	*U. Calif. Pub. Phys.*, I., 1903, p. 7.
Acmæa sp.	10 c.c. 2.5 *m* KCl to 100 s.w. 2 hrs.	To s.w. Swimming larvæ.		Loeb, J.	*Id.*

MOLLUSCS.—*Continued.*

Egg of	Preliminary Treatment.	After Treatment and Remarks.	Per Cent.	Observer.	Reference.
		For artificial maturation methods see		Loeb, J. Wolfsohn, J. M.	*Id.*, III., p. 1, 1905. BIOL. BULL., 13, p. 344, 1907.
Lottia gigantea.	Hypertonic alkaline solution (50 c.c. 5/8 *m* Van't Hoff+10 c.c. 2.5 *n* NaCl+0.5 c.c. *n*/10 NaOH for 2 hrs.	To s.w. Swimming larvæ.	Almost all.	Loeb, J.	*Arch. f. d. ges. Physiol.*, 118, p. 575, 1907.
		STAR-FISH.			
Asterias glacialis.	Hypertonic sea water (by K, Na, Mg. .73 *n.*) for 1 hr.	To s.w. Blastulæ.		Delage, Y.	*Arch. d. Z. Exp. et Gen.*, 3d, 9, p. 307, 1901.
"	Heat (s.w. at 28°–35° allowed to cool by radiation or by cold).	Blastulæ.	25	"	*Id.*, p. 307.
"	Acid (HCl 0.1–0.2 g. per L.) to s.w.	"	50	"	*Id.*, p. 309.
		Heat+KCl s.w. to s.w.	40		
		Heat+HCl s.w. to s.w.	100		
"	Manganese sea water. s.w.–.260 .506 m. } .506 *m.* $MnCl_2$–.246 }	To s.w. segmentations.	5	"	
		$MnCl_2$ s.w.+HCl to s.w.		"	*Id.*, p. 313.
"	.52 m. $MnCl_2$	To s.w.	45		*Id.*, 4th, 3, Notes et Revue, p. clxvi; also *C. R. Ac. Sc. Paris*, 140, p. 1369, 1905.
"	CO_2 Charged s.w. for 1 hr. (between breakdown of germinal vesicle and appearance of ♀ pronuc.).	To s.w. "Auriculariæ."	100	"	*Id.*, 3d, 10, p. 213, 1902, and *C. R. Ac. Sc. Paris*, 135, p. 605, 15, 570. *Id.*, 137, p. 473.
"	Mechanical agitation.	Segmentation and a few blastulæ.	5–30	"	
"	Sodium phosphate sea water.[1] NaH_2PO_4 .270 } .625 m. s.w. .355 }	Numerous larvæ.	3	"	*Arch. d. zool. Exp. et Gen.*, 4th, 3, Notes et Revue, p. clxviii, 1905.

[1] Efficiency probably due to presence of H ions.

STAR-FISH.—*Continued.*

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Asterias forbesii.	Cold (s.w. at 4°–7° C. for 1–9 hrs., after maturation).	Bipinnaria larvæ.	20	Greeley, A. W.	*Am. Journ. Physiol.*, VI., p. 296, 1902.
Asterias forbesii	Heat (s.w. at 35°–70 min.; 36°–45 min.; 37°–30 min. 38°–20 min.; after dissolution of germinal vesicle and before separation of 1st. P.B.).	To s.w. Bipinnaria larvæ.	High.	Lillie, R. S.	*J. Exp. Zool.*, V., p. 375, 1908.
"	*m*/2000 KCW in s.w. for 50 min., then heat (as above).	To s.w. Bipinnaria larvæ.	100	"	*J. Exp. Zool.*, V., p. 375, 1908.
	m/2000 KCN in s.w. for 50 min., then heat to *m*/2000 KCN in s.w. for 5–10 min.	To s.w. Bipinnaria larvæ.	100	"	*J. Exp. Zool.*, V., p. 375, 1908.
Asterina.	Acids (5 c.c. *n*/10 fatty acid+50 c.c. s.w. for 1–2 m.).	To s.w. Blastulæ.	10	Loeb, J.	*U. Calif. Pub. Physiol.*, II., p. 147, 1905.
	Fat solvents (amylen, benzol, sat. sols. in s.w.).	Membranes formed.		"	*Id.*, p. 149.
Asterias.	Acids (3–5 c.c. *n*/10 inorganic acid esp. HCl to 100 c.c. s.w. for 3–20 min.).	To s.w. swimming larvæ.	20	Loeb, J., Fischer, M. and Neilson, H.	*Arch. f. d. ges Physiol.*, 87, p. 1, 1901.
		For substances causing maturation see		Loeb, J.,	*Biol. Bull.*, III., p. 295, 1902.
Asterias forbesii.	Mechanical agitation (after maturation; 3 hrs. after shedding optimum time).	Bipinnaria larvæ and gastrulæ.	50	Matthews, A. P., at Woods Hole.	*Am. J. Physiol.*, VI., p. 142, 1902.
Asterias.	Distilled water (1 min.).	To s.w. Larvæ.		Schücking, A., at Naples.	*Arch. f. d. ges. Physiol.*, 97, p. 85, 1903.
"	Electric current (constant, from 2 chromic acid elements). 2 min.	Segmentation.		Schücking, A., at Naples.	*Id.*
"	Acids (acetic and citric) 2 drops conc. CH_3 COOH to 200 c.c. s.w. for 40 min.).	To s.w. larvæ.		Schücking, A. at Naples.	*Id.*

STAR-FISH.—*Continued.*

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Asterias.	$NaHCO_3$ (1.5 per cent. for 1.25 hrs.). Heat (s.w. at 34° C.).	To s.w. Bipinnaria and blastulæ.		Schücking, A., at Naples.	*Arch. f. d. ges. Physiol.*, 97, p. 85, 1903.

SEA-URCHINS.

Strongylocentrotus lividius.	Hypertonic solutions (by KCl, NaCl, $MgCl_2$). s.w. .317[1] / KCl .500 } .817 *n* for 1.5 hrs.	To s.w. Segmentations and blastulæ.	80 75	Delage, Y.	*Arch. d. zool. Exp. et General.*, 3d, 9, 1901, p. 296.
Strongylocentrotus lividius.	Manganese sea water. s.w. .156 / $MnCl_2$ .492 } .648 *n*.	To s.w. Segmentations.	15	"	*Id.*, p. 311.
Strongylocentrotus lividius.	CO_2 sat. s.w. at 28°–30° C. (allowed to cool by radiation) for 1 hr.	To s.w. Larvæ.	60	"	*Id.*, 4th, 2, pp. 43–46, 1904.
Strongylocentrotus lividius.	Nickel and Cobalt sea water (100 c.c. hypertonic s.w. .95 *n*+1–1.5 c.c. *n* $NiCl_2$).	To s.w. $CoCl_2$ less effective. More effective when Ni applied after hypertonic sol.		"	*C. R. Ac. Sc. Paris*, 143, p. 863, 1906.
Strongylocentrotus lividius.	Na hyposulphite sea water[2] (100 c.c. hypertonic s.w. .95 *n*+5–10 drops *n* Na hyposulphite).			"	*C. R. Ac. Sc. Paris*, 143, p. 863, 1906.
Strongylocentrotus lividius.	Acid and alkali [strong hypertonic sol. (41.5 c.c. 2.5 *n* NaCl+2.5 c.c. s.w.+50 c.c. dist. w.) +17 drops *n*/10 HCl for 5–6 min.]	Weak hypertonic sol. (37.5 c.c. 2.5 NaCl+ 2.5 c.c. s.w.+60 c.c. dist. W.)+17 drops NH_4OH for 1 hr. 20 m.; to s.w.	High.	"	*Arch. d. zool. exp. et gen.*, 4th, 7, 1907, p. 445, also *C. R. Ac. Sc. Paris*, 145, p. 218, 1907.
	HNO_3, H_2SO_4, $(COOH)_2$, CH_3COOH, HCOOH favorable but not H_3PO_4 citric, lactic, butyric, tartaric, valerianic or boric.	NaOH; $Ca(OH)_2$, Na_2CO_3 favorable but not KOH. Treatment cannot be reversed Larvæ obtained.			

[1] Gram molecules of the salt in a liter of water. 5/8 m.=.625 m. [2] Efficiency probably due to increase of OH ions.

SEA-URCHINS.—*Continued.*

Egg of	Preliminary treatment	After Treatment and Remarks.	Per cent.	Observer.	Remarks.
Strongylocentrotus lividius.	Tannin and ammonia—50 c.c. sol. (hypo-,[1] iso- and hypertonic sols. of various salts, salt mixtures and sugar)+28 drops *n*/10 tannin ($C_{14}H_{10}O_9$=322) for 5–6 min. Orcinol, resorcinol, phloroglucine, pyrecatechinol. phenol, pyrogallol, oxyhydrochinone, picric, salycylic, vanillic, gallic and protocatechicuic acids may be substituted for tannin.	Then 30 drops *n*/10 NH_4OH added. After 1 hr. to s.w. The most favorable medium is 70 c.c. in cane sugar+30 c.c. s.w. Larvæ obtained.	High.	Delage, Y.	*Arch. d. z. exp. e. gen.*, 4th, 7, 1907, p. 445, and *C. R. Ac. Sc. Paris*, Nov. 4, 1907.
Strongylocentrotus lividius.	Electric charges (P. D. 15 volts+elec. for 30 m.,—elec. for 1.25 hrs. in 70 c.c. m. cane sugar+30 c.c. s.w.	To s.w. segmentations and a few larvæ.	Many. 1	"	*Arch. d. z. exp. et gen.*, 4th, 9, Notes et Revue, XXX., 1908.
Arbacia punctulata.	Cold (s.w. at 0°–5° C. for 1–6 hrs.).	Irregular segmentation.	Small.	Greeley, A. W., at Woods Hole, also Morgan, T. H.	*Am. J. Physiol.*, VI., p. 296, 1902. *Arch. f. Entw.*, X., p. 489, 1900.
Sea urchins	Fat solvents (toluol, benzol, xylol, creasote and oil of cloves).	Membranes formed.		Herbst, C.	*Biol. Centralb.*, 13, p. 14, 1893.
Strongylocentrotus lividius.	Silver and copper salts (metallic Ag and Cu in s.w. also AgCl). No results with Fe, Ni, Pb, Pt or Au.	" "		"	*Mittheil. aus d. z. Stat. zu Neap.*, 16, p. 445, 1904.
Sphærechinus.	Acid (50 cc. s.w.+3 c.c. *n*/10 CH_3COOH for 4–6 min.).	To s.w. Plutei.		"	*Arch. Entwm.*, 22, p. 473, 1906.
Echinus microtuberculatus.	$CHCl_3$ sat. sea water.	Membranes formed.		Hertwig, O. and R.	"Untersuchungen z. Morphologie u. Physiol. der Zena," H. 5, Jena, 1887.
Echinus.	Strychnin (0.1 per cent. strychnin sulphate for .5–3 hrs.).	To s.w. Division.		Hertwig.	"Festschrift fur gegenbauer," 2, p. 21, 1896.

[1] Loeb has shown that these solutions are all hyperosmotic (*C. R. Ac. Sc. Paris*, 146, p. 246, 1908). Isotonic sols. are not necessarily isosmotic (Loeb, *Biochem. Zeit.*, II, p. 144, 1908).

SEA-URCHINS.—*Continued.*

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Arbacia.	Concentrated sea water (by evap.; 500 c.c. s.w. evap. to 250–375 c.c.; for 2 hrs.).	Segmentation and gastrulæ.	90 40	Hunter, S. J., at Woods Hole.	*Am. J. Physiol.*, VI., p. 177, 1902.
Strongylocentrotus purpuratus and *franciscanus.*	Sperm extract (killed by 70–100° and filtered; of *Chiton, Asterias, Asterina, Strongylocentrotus:* equal pts. conc. extract and s.w.).	To s.w. at 8°–10° C. or to hypertonic s.w. (8 c.c. 2.5 NaCl+50 c.c. s.w.) for 35–50 min.	Few. 90	Kupelwieser, H.	*Biol. Centralb.*, 26, p. 744, 1906.
Arbacia, Strongylocentrotus.	Hypertonic sea water (50 c.c. 20/8 *n* $MgCl_2$ +5 c.c. s.w. for 2 hrs.), also with NaCl, sugar, urea (10 c.c. NaCl or KCl 2.5 *n*+90 c.c s.w. for 2 hrs.).	To s.w. Plutei.		Loeb, J., at Woods Hole and Pacific Grove.	*Am. Journ. Physiol.*, III., p. 135, 1899; IV., p. 178, 1900; III., p. 434, 1900.
Strongylocentrotus, purpuratus and *franciscanus.*	Acids (monobasic fatty). 0.6 c.c. m. ethyl acetate [1] to 50 c.c. s.w.	Hypertonic s.w. (7–8 c.c. 2.5 *n* KCl+50 c.c. s.w. for 25–50 m.) to s.w. Larvæ obtained.	90–100	Loeb, J.	*U. Calif. Pub. Physiol.*, II., p. 83, 1905.
	3 c.c. *n*/10 fatty acid to 50 c.c. s.w. for 2–3 m.	Hypertonic s.w. 25–50 min. to s.w.	90–100 Few.	"	*Id.*, p. 113.
	4 c.c. *n*/10 HNO_3 to 50 for 2–5 min.				
	Hypertonic s.w. (7–8 c.c. 2.5 *n* KCl+50 c.c. s.w. for 1.5–2 hrs.).	3 c.c. *n*/10 CH_3COOH +50 c.c. s.w. for 2–3 min. to s.w.	90–100	"	*Id.*, p. 89.
Strongylocentrotus.	Fat solvents (sal. sols. of toluol, amylene, etc., in s.w.) phenol (6 c.c. *m*/2 phenol to 50 c.c. s.w.).	After membrane formation, hypertonic treatment to s.w. Larvæ.	Small.	"	*Id.*, III., p. 74, 1907.
"	Alkalies (50 c.c. 5/8 *m* Vant' Hoff's sol.+ 0.5–1.0 c.c. *n*/10 NaOH for 2 hrs.).	Hypertonic s.w. for 30–50 m. to s.w. plutei.	Majority.	"	*Arch. f. d. ges. Physiol.*, 118, p. 30, 1907, and 118, p. 572, 1907.
	Hypertonic Vant' Hoff's sol. (50 c.c. sol.+ 8 c.c. 2.5 NaCl for 2 hrs.).	50 c.c. 5/8 sol. or s.w.+ 1.5 c.c. NaOH for 1.5–2hrs.			

[1] Free CH_3COOH present.

SEA-URCHIN.—*Continued.*

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Strongylocentrotus.	Blood sera (of worms, *Dendrostoma* and *Sipunculus* diluted 1,000–5,000 times with s.w.).	To s.w. after membrane formation gives 16–32 cell stages. Hypertonic treatment gives plutei.	10–90	Loeb, J.	*Arch. f. d. ges. Physiol.*, 118, p. 36, 1907, and *U. Calif. Pub. Physiol.*, 3. p. 57. 1907.
"	Saponin, solanin, digitalin. (A trace in 5 c.c. s.w. for 5–8 m.)	Hypertonic sea water for 35–80 min.; larvæ.	10–80	"	*Arch. f. d. ges. Physiol.*' 122, p. 196, 1908.
	Bile salts (Na glycocholate and Na taurocholate).	Hypertonic sea water for 35–80 min.; larvæ.		"	*Arch. f. d. ges. Physiol.*, 122, p. 196, 1908.
	Heat (slow warming to 34°–35°).	Membranes formed.		"	*Arch. f. d. ges. Physiol.*,
	Blood serum (rabbit—6–7 c.c.+1 c.c. 2.5 NaCl or 4 c.c. s.w.+4 drops serum).	After membranes formed and hypertonic treatment, larvæ produced.	Most.	"	122, p. 196, 1908. *Arch. f. d. ges. Physiol.*' 122, p. 196, 1908.
"	Blood serum (pig and ox) treated as with rabbit serum.	Sr and Ba increase activity, Mg and Ca decrease activity of serum.		"	*Id.*, 124, p. 37. 1908.
"	Soaps (only if trace free acid present).			"	*Id.*, p. 45.
Sea urchins of California coast.	Membrane formation by any method.	Hypertonic solutions for 58 min. at 15° C.		"	*Biochem. Zeit.*, 11, p. 144, 1908.
		Saccharose 0.96 m.,	80		
		Glucose 1.04 m.,			
		NaCl 0.79 m.,	90		
		KCl 0.78 m.,	90		
		LiCl 0.74 m.,	80		
		$CaCl_2$ 0.50 m.,	80		
		$MgCl_2$ 0.87 m.,	85		
		$SrCl_2$ 0.70 m.,	80		
		Urea 1.50 m.,			

SEA-URCHINS.—*Continued.*

Egg of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Sea-urchins of California coast.	Membrane formation by any method.	Hypertonic sea water for 25–50 min.		Loeb, J.	*Id.*
Sea-urchins of California coast	" " " "	50 c.c. s.w.+8 c.c. 2.5 KCl, 50 c.c. s.w.+6.5 c.c. 2.5 LiCl, 50 c.c. s.w.+5 c.c. 2.5 $CaCl_2$, 50 c.c. s.w.+4.5 c.c. 2.5 $MgCl_2$, 50 c.c. s.w.+12 c.c. s.w. $MgSO_4$, 50 c.c. s.w. +14.4 c.c. 2.5 glucose, 50 c.c. s.w.+10 c.c. 2.5 saccharose.		"	
Sea-urchins of California coast.	" " " "	Sea water at 2–5° C.		"	Article on parthenogenesis in Oppenheimer's "Handbuch der Biochemie des Menschen u. der Tiere, B. II., 1st half, p. 97, Jena, 1909. Also *Biochem. Zeit.*, I., p. 202, 1906.
Sea-urchins of California coast.	" " " "	Oxygen-free s.w. by current of hydrogen.		"	
Sea-urchins of California coast.	" " " "	KCN sea water (1.5–1 c.c. 0.1 per cent. KCN+50 c.c. s.w. for 5–8 hrs.).		"	
Sea-urchins of California coast.	" " " "	Chloral hydrate s.w. (3 c.c. *n*/10 chloral hydrate +50 c.c. s.w. for 3–6 hrs.).		"	

SEA-URCHINS.—*Continued.*

Key of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Arbacia pustulata and *Strongylocentrotus lividius.*	Acids (2–7 c.c. *n*/10 HCl+100 c.c. s.w. for 5–15 min.) (dilute (1/2–1/6 sat.) CO_2 sea water 2–20 min.)	To s.w. Plutei. To s.w. segmentations and a few larvæ.	10	Lyon, E. P., at Naples.	*Am. Journ. Physiol.*, IX., p. 308, 1903.
	Hypertonic sea water (10–16 c.c. 2.5 *n* KCl or NaCl+100 c.c. s.w. for 1–2 hrs.).	To s.w. Plutei.	High.	Lyon, E. P., at Naples.	*Am. Journ. Physiol.*, IX., p. 308, 1903.
	KCN *m*/100–*m*/1,000 for 1–2 days.	To s.w. No larvæ but segmentations.	High.	Lyon, E. P., at Naples.	*Am. Journ. Physiol.*, IX., p. 308, 1903.
Arbacia.	O-free sea water (by H gas; 30 min. or longer).	To s.w. Divisions.		Mathews, A. P., at Woods Hole.	*Am. J. Physiol.*, IV, p. 343, 1900.
"	Alcohol (10 c.c. s.w.+1 c.c. 50 per cent. C_2H_5OH for 10–15 min.). Also saturated ether and $CHCl_3$ sea water.	To s.w. Divisions.			
"	Pilocarpine, strychnine and quinine.	To s.w. Divisions.			
Arbacia pustulata.	Distilled water (1 min.).	To s.w. Larvæ.		Schücking, A.	*Arch. f. d. ges. Physiol.*, 97, p. 85, 1903.
	Cold (3–4° C. for 3 hrs.).	To s.w. Blastulæ.		"	*Id.*
	$NaHCO_3$ (1.5 per cent. for 10 min.).	To s.w. Gastrulæ.		"	*Id.*
Strongylocentrotus lividius.	Nicotin, hyocyamin, strychnine (1 drop nicotin to 100 c.c. s.w.); 1 part 0.25 per cent. hyocyamin+3 parts s.w.	After 2 hrs. to s.w. Irregular segmentation.		Wassilieff, A., at Villefranche.	*Biol. Centralb.*, 22, p. 738, 1902.
Toxopneustes.	Hypertonic sea water (1 part s.w.+ 1 part 20/8 *m* $MgCl_2$ for 1–2 hrs.).	To s.w. Plutei.		Wilson, E. B. at Beaufort.	*Arch. Entwm.*, XII., p. 529, 1901.

VERTEBRATES.

Key of	Preliminary treatment.	After Treatment and Remarks.	Per cent.	Observer.	Reference.
Leuciscus rutilis.	Hypertonic solutions (10 per cent. cane sugar 3 hrs., 1 per cent. NaCl, 3 hrs.)	To water. Irreg. segmentations but furrows later disappear; development questionable.	50	Bataillon, E.	*Arch. Entwm.*, XI., p. 169, 1900, and *C. R. Ac. Sc. Paris*, 134, p. 918, 1902.
Rana esculenta.	Ox serum. 1–2.5 hrs.	To water. Segmentation	90	"	*Arch. Entwm.*, 18, p. 17, 1904, and *C. R. Ac. Sc. Paris*, 137, p. 79, 1903.
Rana fusca.	Heat (water at 35° for 30 min.).	To water. Segmentation		"	
" "	Hypertonic sols. (6 per cent. cane sugar, 8–15 hrs.).	To water. Segmentation		"	
" "	Heat+6–8 per cent. cane sugar.	Blastulæ.		"	
Petromyzon planeri.	Hypertonic sols. 6 per cent. cane sugar.	Segmentation.		"	*Id.*
Fish.	Diphtheria antitoxin.	Segmentation?		Kulagin.	*Zool. Ans.*, 1898, p. 653.

PELAGOSPHÆRA, A LARVAL GEPHYREAN.

HAROLD HEATH.

In 1905 Dr. Pio Mingazzini published an account[1] of a gephyrean worm taken at a depth of 4,500 meters during an expedition of the Duke of Abruzzi in the neighborhood of Aukland. It is described as a spherical transparent organism, of about 6 mm. diameter, with a decided resemblance to certain sipunculid larvæ. However, as the author considered it to be an adult, it was placed in a new genus for which he states a new family may have to be created.

Spengel[2] chiefly on the basis of *Sipunculus* larvæ taken in the Bay of Naples, declares without hesitation that the animal in question is a larval form differing in a few minor details from other well-known types. The so-called gonad may well be the glandular appendages of the oesophagus noted in the young of several species.

During the past year two individuals, belonging to this proposed genus, have been taken in the surface plankton of Monterey Bay, Cal., and there is no doubt they are immature, the "gonadi" being, as Spengel surmised, glandular appendages of the pharynx. Nevertheless they present a number of features of considerable interest that are herewith described in some detail.

Both, apparently belonging to the same species, are spherical and measure 2.5 and 3.2 mm. respectively. In life the body wall was almost transparent, the muscles, especially those radiating from the mouth opening, appearing much as they do in *Doliolum* or *Salpa*. The alimentary canal was light yellow and the nerve cord and especially the brain were more opaque and fairly distinct.

The most prominent structure of these animals is the alimentary canal, which in its general features resembles that of the

[1] "Un Gefireo pelagico: *Pelagosphæra aloysii* n. gen. n. sp.," *Rendic. Accad. Lincei, cl. sc. fis., mat. nat.* (5), Vol. 14, pp. 713–720.

[2] "Eine verkannte Sipunculus-Larve," *Zool. Anz.*, Bd. 31, 1907

species studied by Mingazzini though there are some important organs that have remained undescribed. The mouth (*m*) opens into a gradually enlarging cavity, lined with a continuation of the cuticle surrounding the body as far as the opening of the ventral glands. At this point a large pouch-like diverticulum (*d*) is developed chiefly on the dorsal side of the gut, and the naked cells of its lining epithelium are relatively high and slender and bear an excessively heavy coat of cilia at least two or three times their own length. In his figures Mingazzini represents six large retractors and a few smaller strands attaching to this point

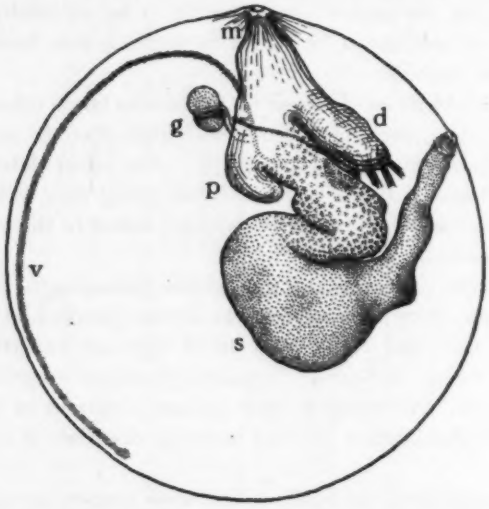

FIG. 1. Larval gephyrean (*Pelagosphaera*). The stippling of the gut is merely to differentiate the different divisions. *d*, dorsal ciliated diverticulum; *g*, glands and duct, slightly displaced; *m*, mouth; *p*, ventrical non-ciliated pouch or pharynx; *s*, stomach-intestine; *v*, ventral nerve cord leading to brain partially concealed by pouch *d*.

(though there is no sign of a pouch) and on the other hand radiating outward to become united to the body wall. In the present specimens the same is true. It appears probable therefore that this ciliated diverticulum may be everted and act as a locomotor organ as Wilson[1] has described in the case of *Echiurus*

[1] "Our North American Echiurids," BIOL. BULL., Vol. 1, 1900.

pallasii. And furthermore the proboscis or everted portion would, owing to its dorsal position, form a protuberance on the dorsal side of the mouth which would be situated, as in *Echiurus*, at its base. Perhaps to facilitate the eversion of this part of the digestive tract another outpouching (*p*) occurs on the ventral side of the gut, but its cells though columnar lack the ciliated coat, and it is without special retractor muscles.

This reference to *Echiurus* does not necessarily prejudice one in favor of the belief that the larvæ in question belong to this or allied genera. Setæ are totally lacking, there are no signs of segmentation, and so far as may be seen there are no cilia on the external surface of the body as in other gephyrean larvæ. For the present, at least, the question of systematic relationships cannot therefore be definitely determined.

Ventral to the gut in this same region are two spheroidal glands (*g*) in close contact with each other. In life they bear a fairly close resemblance to ova, which doubtless led Mingazzini to describe these organs as the gonad. Each is composed of a mass of pyriform cells, densely packed with a finely granular secretion from which ductules extend toward the inner face of each gland. A small duct, opening into the pharynx or œsophagus, extends anteriorly a short distance, and then bending ventrally it passes between the two glands whose ductules unite with it.

Beyond this point the digestive tract pursues an irregular course, and bending on itself passes dorsally to the anal opening. Three distinct divisions are clearly defined, the oesophagus, stomach-intestine and rectum. The first of these is of irregular outline, of relatively large caliber and its walls throughout are composed of columnar cells bearing a coat of delicate cilia. In the region of the stomach-intestine it narrows considerably and its walls become longitudinally folded. The stomach-intestine (*s*) is at first a comparatively large sac with highly glandular walls, each gland cell pyriform with the swollen distal end distended by some lightly staining, vacuolated secretion. Diatoms occur in this section of the tract together with small quantities of some other material, all of it enveloped in a stringy looking coagulum. Although the gut is narrowed for a considerable dis-

tance before the rectum is reached, and appears in whole mounts to be differentiated into a definite intestine, sections show that this same glandular epithelium extends from œsophagus to rectum. This latter structure is characterized by longitudinally folded walls lined with cuticle and provided near the anal opening with a strong sphincter muscle.

The nervous system is free from the ectoderm and is constructed upon the usual gephyrean plan. Posteriorly the nerve cord terminates in a slight enlargement, as noted by Mingazzini, and on the other hand, after following the body wall to a point close to the pharynx it bends inward and in the neighborhood of the duct of the ventral glands bifurcates to form the œsophageal collar. The course of these connectives in two or three sections is difficult to follow, owing to their small size and the abundance of connective tissue and muscle fibers, but the plan shown in the figure is probably not far astray. The bilobed brain is very distinct in both sections and in whole mounts, but it has been impossible to trace any nerves from it with the exception of the connectives.

The kidneys are two in number and consist of short coiled tubes opening to the exterior. I have examined these organs with much care but have failed to find that they have any internal opening. In every case the two extremities are in close contact, but the glandular portion includes the distal extremity, apparently, and if any inner pore does exist it is minute and not a well-developed nephrostome. The gland cells are fairly well defined, more or less vacuolated and contain considerable quantities of a finely granular secretion. In the neighborhood of the pore the glandular elements disappear, the canal becomes of much smaller caliber and after a short, sharp twist opens to the exterior.

The fatty substance described by Mingazzini is lacking in the present specimens, though in all probability this may be a variable feature. Also no trace of sex cells has been found, and there is therefore no reason to consider this an adult form so that a generic name is uncalled for as Spengel maintains.